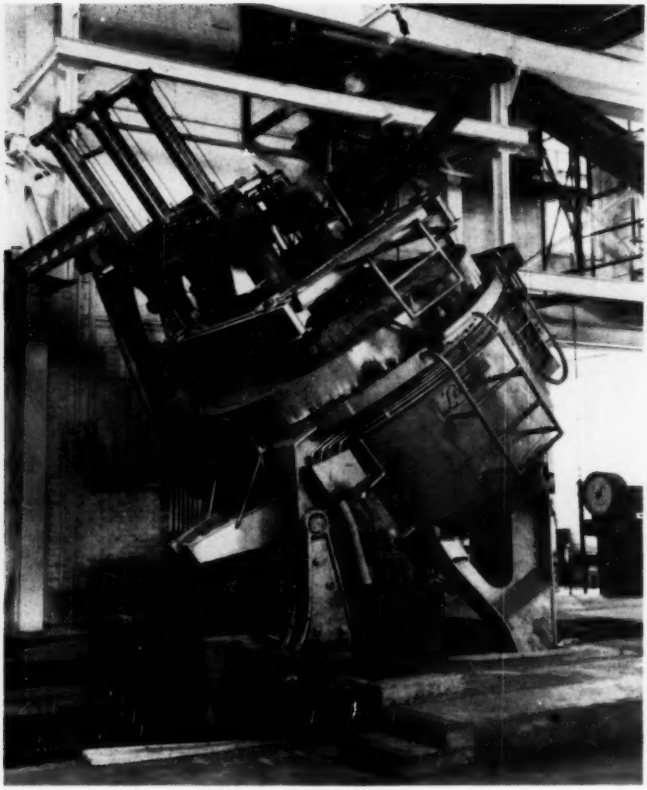
★ THE FOUNDRYMEN'S Own MAGAZINE

American Foundryman

JULY
1949



Melting the New Nodular Ductile Irons

Lectromelt Furnaces, like the size CQT pictured above, provide the close control of analysis and temperature required for successful utilization of the new nodular ductile irons. These furnaces readily reduce the sulphur and phosphorous content to the low limits needed to obtain the highest physical properties.

* * * *

Lectromelt Forehearth Furnaces are being used in increasing numbers for control and adjustment of the analysis and temperature of metal melted in other equipment. They are especially designed for operation in conjunction with existing cupolas or air furnaces.

Write today for detailed information of Lectromelt's complete range of Forehearth and regular melting furnaces.

PITTSBURGH LECTROMELT FURNACE CORPORATION
PITTSBURGH 30, PENNSYLVANIA

MOORE RAPID *Lectromelt* FURNACES

manufactured in: CANADA, Lectromelt Furnaces of Canada, Ltd., Toronto 2; ENGLAND, Birlec, Ltd., Birmingham; SWEDEN, Birlec Elektkougnar A B, Stockholm; AUSTRALIA, Birlec Ltd., Sydney; FRANCE, Stein et Roubaix, Paris; BELGIUM, S. A. Belge Stein et Roubaix, Bressoux-Liege; SPAIN, General Electrica Espanola, Bilbao; ITALY, Forni Stein, Genoa.

SIGNS of the trend...

Here's an 18-second summary on why most foundries use Crown Hill Seacoal Facing for venting molds.

● The high volatile content (see Bureau of Mines figures) of Crown Hill means quick flash. Since the fusion point of the small ash residue is 2980° F., molten iron cannot fuse it, and low sulphur content eliminates hard spots. In short, peeling is easy and cleaning costs *come down.* Try Crown Hill, choice of most foundrymen.

FIGURES FROM BUREAU OF MINES
DEPT. OF INTERIOR OF THE U. S.

(Moisture Free)

PROXIMATE ANALYSIS

Volatile Matter (V.C.M.)	38.9%
Fixed Carbon	57.4%
Ash	3.7%
	100.0%

ULTIMATE ANALYSIS

Hydrogen	5.4%
Carbon	82.0%
Nitrogen	1.6%
Oxygen	6.6%
Sulphur	.7%
Ash	3.7%
	100.0%

Fusion Point of Ash . . . 2980°F

THE FEDERAL FOUNDRY SUPPLY COMPANY

Seacoal Plant
CROWN HILL, W. VA. • CHICAGO
CHATTANOOGA, TENN.

DETROIT • MILWAUKEE
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IN TWIN CITIES: The Foundry Supply Co., Inc.,
404 South Third St., Minneapolis 15, Minn.

4600 East 71st Street
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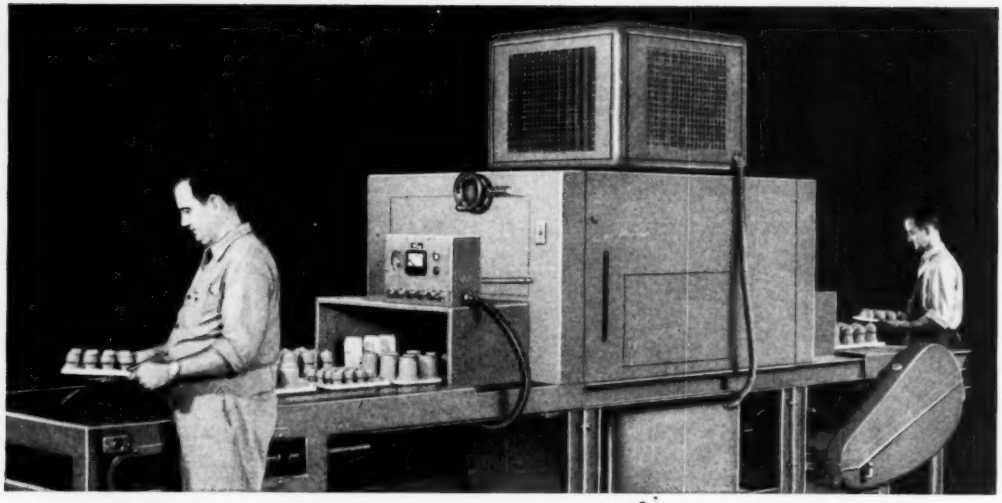

Push-button baking of foundry cores

NOW you can have straight line, conveyorized, continuous core baking in a compact unit designed to save space, time, and labor!

Thermex High Frequency Core Baking Equipment produces superior foundry cores in a matter of minutes . . . cores that possess greatly improved shakeout and collapsibility characteristics.

With Thermex Core Baking Equipment, you'll save thousands of dollars annually in labor costs alone. The capacity of your mulling equipment is doubled. Far fewer mixes are required to produce a variety of cores. The labor involved in removing and re-racking core plates is eliminated . . . the cores go directly to the inspection table from your Thermex Core Baking Equipment. The cores themselves have no burned or broken surfaces to cause ridges, pits, or fins that must be removed from the castings.

How's that for saving costly man-hours that add up to cold, hard cash?

You'll want the complete, fact-filled story contained in our folder, "Thermex High Frequency Core Baking Equipment". It's interesting and it's important . . . to you. Send for your copy today!

Thermex

T. M. Reg. U. S. Pat. Off.

HIGH FREQUENCY CORE BAKING EQUIPMENT

The Girdler Corporation, Thermex Division

Louisville 1, Kentucky

FACTS about Thermex Core Baking Equipment

INSTALLED COST

Usually less than conventional ovens. Equipment—*complete with conveyor*—is simply placed in position and connected to power line.

OPERATING COST

Power is used only when cores are being baked and in proportion to the type and quantity. No power or time is lost in starting or in shutting down production.

MAINTENANCE COST

Negligible, because operation is remarkably simple. Only moving parts are the conveyor and exhaust blower. Push-button controls.

BINDER COST

Actually no more than the cheaper oil binders, because only one-third to one-half as much synthetic resin binder is required. A wide variety of proved resin binders is now available.

CASTING CLEANING COST

The labor normally required for correction of defects such as blow holes, pits, etc., in the casting is reduced to a minimum.

A. F. S.
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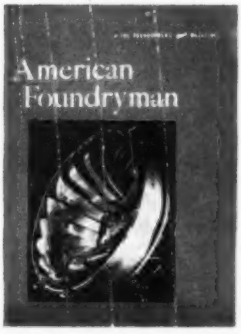

The American Foundrymen's Society is not responsible for statements or opinions advanced by authors of papers printed in its publication.

This Month's Cover

This month's cover shows a cast steel runner (rotating or water wheel element) for a hydraulic turbine. It is one of four 35,000 hp, 92-ft head, 100-rpm hydraulic turbines being built by Allis-Chalmers Mfg. Co. for the Tennessee Valley Authority. As machined, the runner is 173 in. in diameter and 100 in. high, weighing about 95,000 lb. In one of the final steps before shipment, a worker with a portable grinder is removing undue roughness from the runner vanes. Allis-Chalmers photo by Michael Durante.

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Lynchburg foundry

mexacote

Lynchburg worker spraying green resin core for clutch housing with a 15° Mexacote solution. Green resin core for transmission is waiting to be sprayed. Baked cores may be dipped for Mexacote treatment.

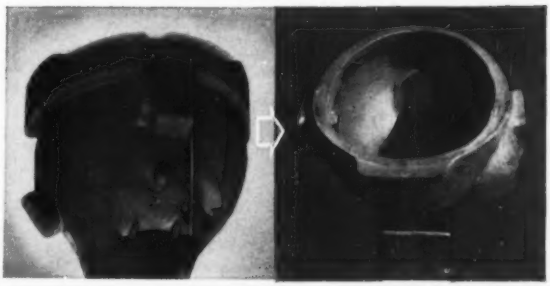
Mexacote-sprayed green resin core for clutch housing is placed in the oven for drying. Some cores are first baked and then given a 40° Baume' coating of Mexacote.

THE UNITED STATES GRAPHITE COMPANY

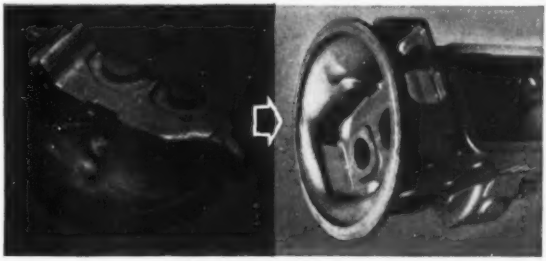
sprays cores with for finer casting finish

To find a product that would produce a high surface hardness on their cores and give a better casting finish, the Lynchburg Foundry Company tested many different products. After exhaustive tests on a wide variety of cores they found that MEXACOTE would do exactly what they wanted it to do. Say Lynchburg engineers: "Now we spray all cores—where spraying is possible—with a 15° Baume' solution of MEXACOTE and the results have been highly satisfactory."

When you want a better casting finish, spray or dip molds and cores with MEXACOTE. It quickly mixes with water and thins to a spraying consistency. MEXACOTE forms a firm coating that will not crack, shrink, scab, peel or buckle under heat, and can be dried by torch, lamp, or oven. A solution of 20° Baume' is usually recommended for spraying, 35° for dipping. MEXACOTE holds true core dimensions, does not run or build up—penetrates sand to prevent burning in. Write for special MEXACOTE bulletin.



From core to casting. The picture at left shows one part of the core assembly for clutch housing after having been sprayed green with Mexacote and baked. At right is the casting. Note fine finish that will require minimum finishing.



At left, resin cores for part of truck transmission case are sprayed green with Mexacote. At right is the transmission case after casting. Note absence of veining of cored surfaces.

mexacote

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

Revivo GIVES YOU MOST BOND *Strength* FOR EVERY DOLLAR

Your sand needs strength, but at minimum cost. Revivo is low in first cost and has high durability. The foundry which properly uses Revivo Bond has the lowest sand cost which it is possible to obtain from any clay of any type. *Plus*—wide moisture range and high sintering point.

If your precise requirements are not met with Revivo Bond, they will be with one of our other four clays, or a combination of them.

★ ★ ★

EASTERN CLAY PRODUCTS, Inc.
JACKSON, OHIO

REVIVO BOND

Revivo is one of five ECP products. These, with many combinations, enable us always to recommend the very best bonding clay or variation for your exact purpose.

APEX

Z-50

ALLOY

Your production line is your profit line—safeguard it by using APEX Z-50, a proven quality alloy. Having uniform casting characteristics with better-than-average mechanical properties, *and free machinability*, APEX Z-50 will meet most of your casting requirements. When quality plus economy is paramount, specify APEX Z-50—"Proved Best By Test"!

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Chicago • Cleveland

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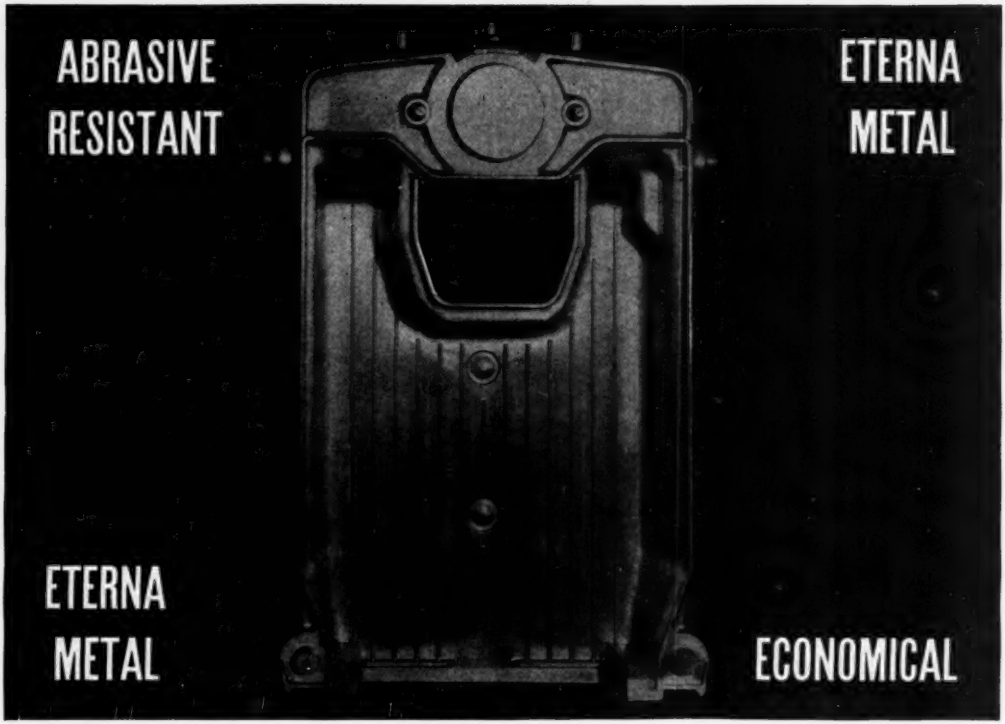

We Have Perfected a New Metal

THIS new Eterna metal possesses unusual wear-resistant qualities never before equalled for hardness and long life pattern service. It is a heat-treated alloy; and after the heat-treatment, a hardness will average between Rockwell B-75 and B-90. This outstanding property alone is responsible for imparting to the patterns their long durability. We are using this alloy to replace other metals in the construction of metal patterns; and reports that we have received on these patterns indicate that the material will outwear the metals ordinarily used, more than two to one. It also lends itself to producing better pattern castings as the metal flows freely in the mold and also reproduces more accurately. The material can be soldered or brazed, thus allowing for design changes when necessary.

We welcome inquiries for further information and assure you of a prompt reply.

WOOD AND METAL PATTERNS
KELLER AND DUPLICATOR WORK
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MALLORY METALS
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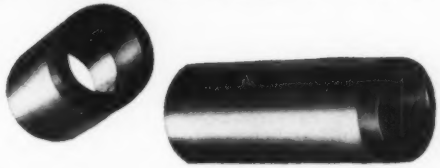
1913 — 36 YEARS OF RESEARCH — 1949

EVERDUR CASTINGS
COPPER CASTINGS OF HIGHEST ELECTRICAL CONDUCTIVITY
PERMANENT MOULDS
BRASS, BRONZE AND ALUMINUM CASTINGS

HOLD THAT SAND!...

WITH AMAZING NEW SAND ARRESTER TUBE!

(Patent Applied For)



POSITIVELY ELIMINATES SAND STEMS ON BLOWN CORES!

1. GUARANTEED FOR MORE THAN 100,000 BLOWS.
2. AUTOMATICALLY DELIVERS PERFECT CORES.
3. APPROVED BY THE MOST EXPERIENCED FOUNDRYMEN.
4. INSTALL WITHOUT SPECIAL TOOLS.
5. SIMPLE TO INSTALL — PUSH OUT THE OLD — PUSH IN THE NEW.
6. SPECIAL QUALITY, WEAR RESISTANT RUBBER — NOT AFFECTED BY ABRASION, OIL, WATER or TIME.
7. TOUGH ELASTIC RUBBER FUSED TO SEAMLESS STEEL TUBES BY OUR OWN SPECIAL PROCESS.
8. STEEL TUBE HEAVILY PLATED AND RUST PROOF.
9. SAND FLOWS FREELY INTO CORE BOX.
10. SAVE CORES, TIME and MONEY.

WE ARE PREPARED TO MAKE UP FOR YOU ENOUGH TUBES TO FIT ANY CORE BOX YOU CHOOSE. IF AT THE END OF THIRTY DAYS YOU FEEL THAT THE TUBES ARE NOT WORTH WHAT YOU PAID, YOU MAY RETURN THEM FOR FULL CREDIT.

TUBES ARE PRICED AS FOLLOWS:

⅜" x 2"	$1.70
½" x 2"	1.90
⅝" x 2"	2.25
¾" x 2"	2.35
1" x 2"	2.45

Add 10c for each additional inch or fraction of length.

THIRTY DAY TRIAL COUPON

Number needed _____ ⅜" O.D. by _____ long

Number needed _____ ½" O.D. by _____ long

Number needed _____ ⅝" O.D. by _____ long

Number needed _____ ¾" O.D. by _____ long

Number needed _____ 1" O.D. by _____ long

Tubes of any length or diameter can be made — we invite your inquiry.

FILL IN THE ORDER COUPON NOW! — INSTALL SAND ARRESTER TUBES WITHOUT DELAY!

MARTIN ENGINEERING COMPANY

704 Rose St., Kewanee 1, Ill.

FOR FASTER PRODUCTION OF...

Better, Cleaner Castings

STEEL, MALLEABLE, GREY IRON, NON-FERROUS USE...

DELTA CORE & MOLD WASHES

Three easy-to-understand reasons why more foundries use DELTA Core and Mold Washes . . .

1. MORE PERFECT CASTINGS . . . 2. LOWER CLEANING ROOM COSTS . . .

3. LESS SCRAP IN MACHINING.

HERE'S WHY...

a. Delta Core and Mold Washes "Anchor" themselves by penetrating from 3 to 5 grains deep into the sand. This bond between the wash and the sand . . . a distinctive DELTA characteristic . . . produces an expansion-resisting coating essential to the production of finer finished castings.

b. The hot strength of Delta Core and Mold Washes increases with each degree of temperature rise from 1800°F to 3000°F providing maximum critical hot strength for all foundry applications.
The higher hot strength of DELTA Core and Mold Washes eliminates surface sand fissuring, excessive sand expansion and distortion.

c. No gas leakage through Delta Core and Mold washed surfaces. Gases produced by decomposition of organic binders in the core sand cannot leak through Delta Core and Mold washed surfaces to contact the molten metal. Only Delta Core and Mold Washes provide this unique and all-important insurance against defective castings resulting from core gas leakage. DELTA Core and Mold Washes insure more perfect castings with finer finished surfaces.

DELTA CORE & MOLD WASH-BASE
Mix with silica flour and water to produce finished wash.

•

FOR STEEL
STEELKOAT — Special Core and Mold Wash.

•

FOR GREY IRON & MALLEABLE
Grakoat — Blackoat — Hi-temp.

•

FOR NON-FERROUS METALS
Non-FerrusKoat.

•

FOR ALL SAND CAST METALS
THERMOKOAT — It's Plasti-Lastic.
PYROKOAT-Hi-Speed.

•

FOR UNUSUALLY HIGH TEMPERATURE CONDITIONS
Z-KOAT-High-fusion-temp wash.

•

• *Ask for a liberal working sample.*

There is no "just as good" substitute for any DELTA Core and Mold Wash just as there is no substitute for DELTA'S scientific laboratory control of production which safeguards the quality and uniformity of all DELTA Foundry Products. DELTA Research laboratories developed, and pioneered the use of, Plastic-type Core and Mold Washes . . . and still leads the field in the development of new products for improved foundry practices.

DELTA OIL PRODUCTS CO.

MILWAUKEE 9, WISCONSIN

It's Expensive to Heat "ALL OUTDOORS"

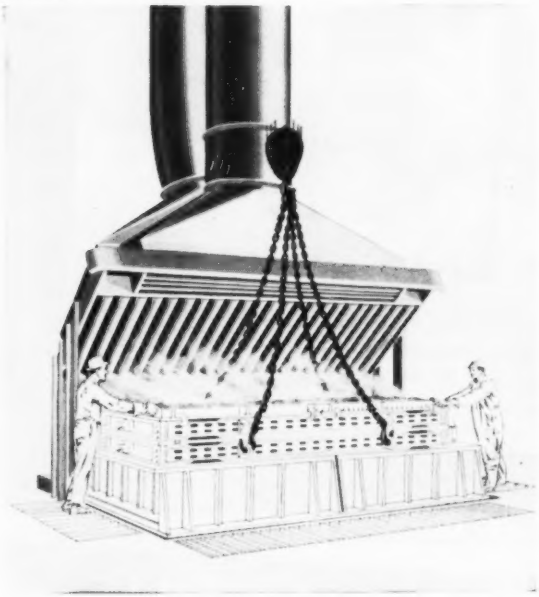
SCHNEIBLE "Compensating Air" HOODS

Save Your Building Heat in Winter!

Though the weather may be hot, now is the logical time to think about next winter's plant efficiency. Those antiquated shakeout hoods may be dissipating extra profits right out of the stacks.

Schneible "Compensating Air" Hoods were designed especially for removal of contaminated air without the usual waste of usable warm air that costs money to produce.

The "Compensating Air" supply, taken from outside the plant prevents "robbing" plant of warm air in severe weather—thus reducing heating costs and preventing undesirable airflow patterns throughout the foundry.



All contaminated air is efficiently conducted to the Schneible Multi-Wash Dust Collector with heavier particles going to the Schneible Velocitrap and then to the shakeout sand conveyor belt.

Put Schneible on your list of "musts" when considering efficient dust and fume control.

ENGINEERING REPRESENTATIVES IN PRINCIPAL CITIES

CHECK your present HOODS for these features!

- ✓ Outside air to work stations in winter months.
- ✓ Air from high inside during the summer.
- ✓ Airflow pattern confined to working stations.
- ✓ Directional air control over shakeout only.
- ✓ Maximum usable floor area retained.
- ✓ Low maintenance and operating costs.

U.S. and Foreign Patents Applied For

For further information, write for Bulletin Number 548.

CLAUDE B. SCHNEIBLE COMPANY
2827 Twenty-Fifth Street • Detroit 16, Michigan

SCHNEIBLE

MULTI-WASH COLLECTORS, VELOCITRAPS, WEARPROOF PUMPS, DEWATERING AND SETTLING TANKS, ENTRAINMENT SEPARATORS.

FERROCARBO Briquettes

THE NEW DEVELOPMENT in malleable iron melting that provides these advantages:

1. Thorough deoxidation.
2. Prolonged increase in fluidity.
3. Less tendency for internal shrinkage.
4. Elimination of shrinkage cracks and hot tears close to or at point where risers feed castings.
5. Less breakage of castings during "shake-out." This results from reduction of massive primary carbides with their marked planes of weakness.
6. The fine, uniform carbide dispersion provides shorter annealing time and evenly distributed graphite nodules.

Actual plant records attest the economies effected by FERROCARBO Briquettes in malleable melting operations. Their possibilities in your plant should not be overlooked. Call in our metallurgical staff for complete information.

FERROCARBO Briquettes

BY **CARBORUNDUM**

TRADE MARK

THE CARBORUNDUM COMPANY, Bonded Products and Abrasive Grain Division, Niagara Falls, New York

FERROCARBO Distributors: Kerchner, Marshall & Co., Pittsburgh, Cleveland, Birmingham, Philadelphia and Buffalo; Miller and Company, Chicago, St. Louis and Cincinnati

"Carborundum" and "Ferrocarbo" are registered trademarks which indicate manufacture by The Carborundum Company

HERE'S HOW...

CHICAGO TRANSIT AUTHORITY CUTS MELTING TIME IN HALF

. . . cuts fuel cost 50% . . . cuts metal losses 40%

Chicago Transit Authority, one of the world's largest transportation systems, operating 2,400 streetcars, 1,625 elevated cars, and 1,100 buses, installed a Fisher oil fired Simplex Melting Furnace for remelting, reclaiming scrap, brass, and bronze. Journal and axle bearing brasses and worn parts from all types of rolling stock are melted down and recast into new parts.

The new Fisher Simplex replaces a conventional oil fired spherical type open flame furnace. Check this "Before and After" story of faster melting, lower fuel cost, and lower metal losses.

	BEFORE	AFTER
Heating time 1000 lb. charge	2½ hrs.	1 hr.
Fuel cost per pound melted	$.0056	$.0027
Metal Loss	5%	3%

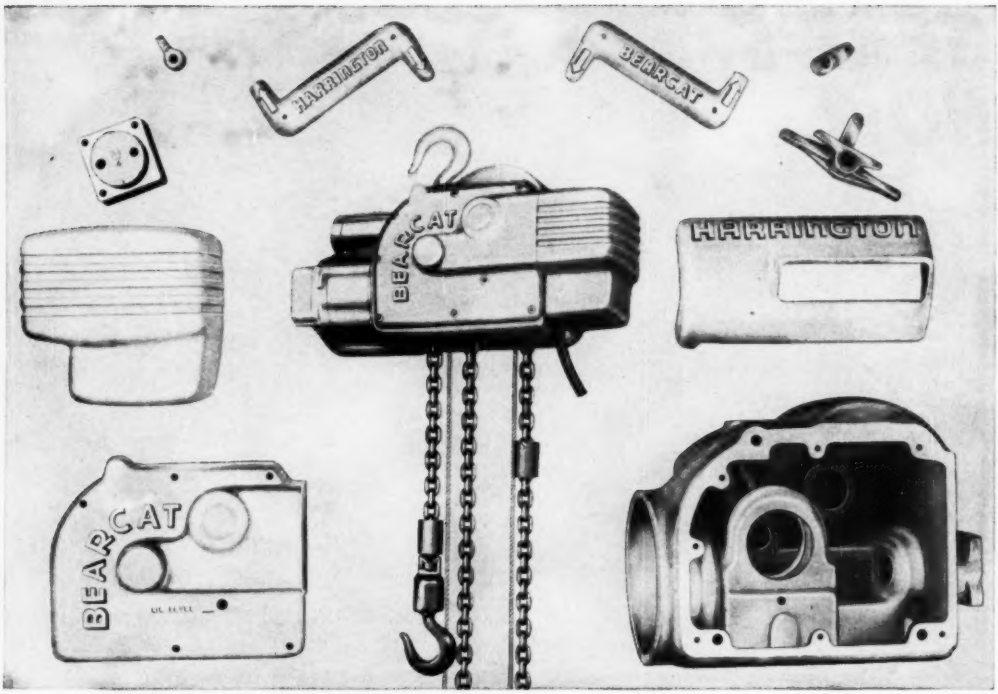
FISHER ADVANTAGES

Furnace charges *easily* from front at convenient height. . . . More scrap can be charged because of large area above molten metal line. . . . Uses open flame reverberatory melting, the *fastest* fuel fired melting method. . . . Two section furnace shell removable for *easy* relining.

Ask for bulletin #28-A "Fisher Simplex Furnaces."

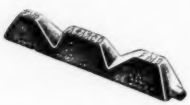
Fisher Furnaces

A DIVISION OF LINDBERG ENGINEERING CO.
2440 West Hubbard Street, Chicago 12, Illinois



JM Lee. P80

Cut Weight, Eliminate Heat Treatment, Improve Properties — with TENZALOY



Casting ten parts of the Bearcat electric hoist (above) in TENZALOY enabled the manufacturer, The Harrington Company, Philadelphia, to:

1. Produce the article without heat treatment, thus saving an added expense.
2. Reduce castings' weight from an average of about 60 lbs. (original ferrous metal design) to 20 lbs., thus improving portability.
3. Cut machining and handling costs.
4. Improve appearance and corrosion properties, thus increasing sales appeal.
5. Virtually eliminate rejects.

The Fisher Casting Company, North Plainfield, N.J., which cast the components shown above, is a longtime user of TENZALOY. Its competent staff knows well this aluminum-magnesium-zinc alloy which Federated developed to give high strength without heat treatment. Therefore, when they recommended TENZALOY, and worked with Harrington and Federated engineers on the project, they were certain of its eventual success.

This happy and profitable experience can be yours, too. Write Federated's Dept. CW for technical pamphlet on TENZALOY.

Federated first in the new ferrous field FMD

Federated METALS DIVISION

AMERICAN SMELTING AND REFINING COMPANY, 120 BROADWAY, NEW YORK 5, N.Y.

LINE-UP TROUBLES DISAPPEAR

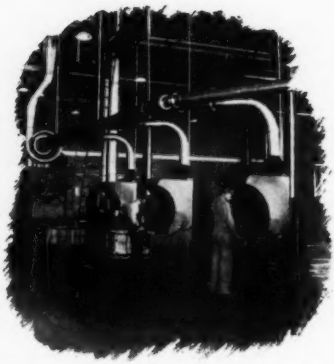
with UNIVERSAL FLASK PINS AND BUSHINGS FOR COPE AND DRAG

Accurate and speedy lineup of cope and drag, saving valuable production minutes, is the experience of the foundry that uses Universal Flask Pins and Bushings. Once installed, they *maintain their stability and accuracy* for hundreds of castings. Cope Bushings are quickly guided to Drag Pins over tapered, loose-fitting Closing Pins which are easily removed after assembly. The special elongated flask bushing permits longitudinal expansion to compensate for metal heat *without affecting accurate alignment.* Universal Flask Pins and Bushings are available from stock in standard sizes for iron, steel, aluminum and magnesium flasks. Special sizes and types to order. Send for folder and complete information.

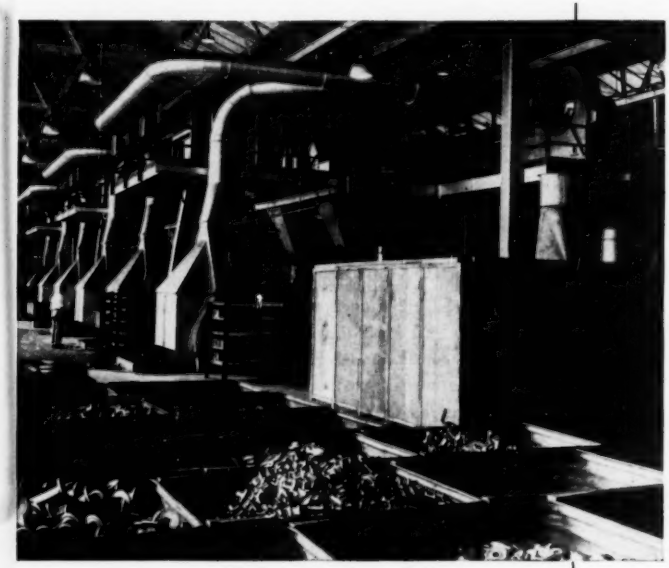
UNIVERSAL ENGINEERING COMPANY

FRANKENMUTH 12, MICHIGAN

48 ROTO-CLONES police dust here!



Memphis Works of International Harvester Employ 3 Types of Roto-Clones For Complete Foundry Dust Control



Three type W Roto-Clones serve these six foundry shakeouts at Memphis Works of International Harvester.

THEY even harvest the dust at International! Grinders (both portable and stand type), abrasive cleaners, sand handling equipment and shakeouts—all are serviced by AAF Roto-Clones*.

Three types of Roto-Clones—D, W, and N—exhausting a total of over 300,000 CFM are used in this modern Memphis foundry. Above you see a battery of portable grinders served by a compact Type D unit. At left is pictured a group of six foundry shakeouts whose dust load is handled by 3 Type W Roto-Clones.

Regardless of the nature or quantity of the dust generated in your plant, there's an AAF Roto-Clone of a type and size designed for highest collection efficiency—plus simplicity, compactness and low operating cost. The experience of engineering Roto-Clones to solve thousands of dust problems is yours for the asking. For complete information, call your nearby AAF representative or write direct to—

AMERICAN AIR FILTER COMPANY, INC.
104 Central Avenue, Louisville 8, Ky.
In Canada: Darling Bros., Ltd., Montreal, P. Q.

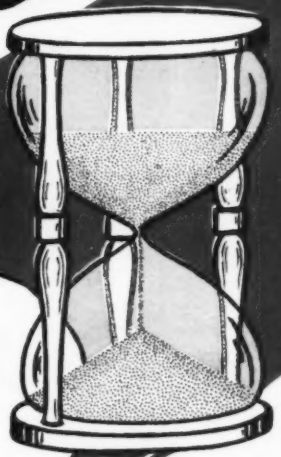
Get the Roto-Clone Story!
Bulletin No. 270-A describes the complete Roto-Clone line, its applications and advantages. Write for it now!

AAF

ROTO-CLONE®
DUST CONTROL EQUIPMENT

*Roto-Clone is the trade-mark (Reg. U. S. Pat. Off.) of the American Air Filter Company, Inc., for various dust collectors of the dynamic precipitator and hydrostatic precipitator types.

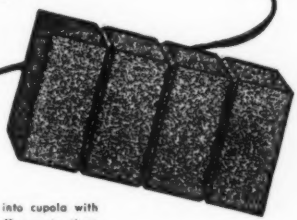
Control



IN THE HOUR GLASS
the size of hole controls the flow of sand.

•

IN CASTINGS
the condition of molten metal controls the quality.



SCORED BRICK FORM
saves time in using.

You simply toss Famous Cornell Flux into cupola with each ton charge of iron or break off one to three briquettes (quarter sections) for smaller charges. This flux does not blow out with the blast but STAYS in melting zone until entirely consumed.

•

MALLEABLE FOUNDRIES, with cupola operation, are showing a rapid trend towards the use of Famous Cornell Cupola Flux. Reports of greatly improved casting production come from every direction. Furthermore, there is a considerable reduction in cupola maintenance labor and cost. The life of cupola lining, whether brick or stone, is greatly prolonged.

PURIFY YOUR METAL, POUR BETTER CASTINGS *by using*

Famous CORNELL CUPOLA FLUX

A trial in your foundry will PROVE this—Metal is hotter and more fluid; sulphur is reduced; castings are sounder, cleaner, and their even grain and freedom from hard spots and hollow centers makes machining definitely easier; rejects are cut amazingly.

Cleaner cupolas, cleaner drops, longer brick life and greatly reduced maintenance cost are other advantages in using Famous Cornell Cupola Flux.

WRITE FOR BULLETIN 46-B

The CLEVELAND FLUX *Company*

1026-1036 MAIN AVENUE, N.W., CLEVELAND 13, OHIO

Manufacturers of Iron, Semi-Steel, Malleable, Brass, Bronze, Aluminum and Ladle Fluxes—Since 1918

FAMOUS FLUXES Trade Mark Registered

Write for Bulletins ➡

Famous CORNELL ALUMINUM FLUX

Produces clean, tough castings. No spongy or porous spots even when more scrap is used. Thinner yet stronger sections are poured. Castings take a higher polish. NO FUMES! Exclusive formula prevents obnoxious gases. Metal does not cling to dross.

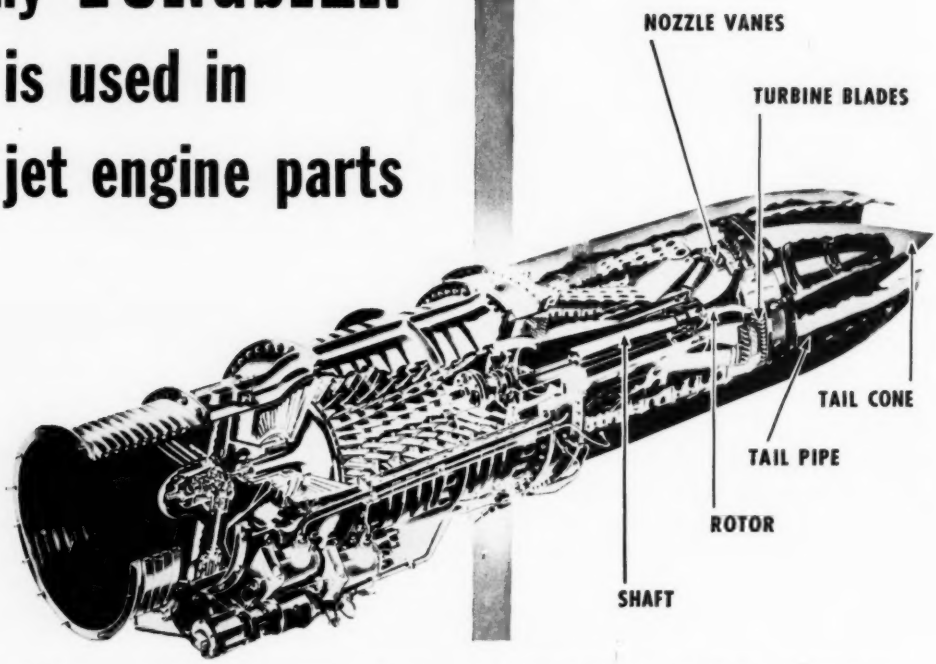
Famous CORNELL BRASS FLUX

Makes metal pure and clean, even when dirtiest brass turnings or sweepings are used. Produces castings which withstand high pressure tests and take a beautiful finish. Saves considerable tin and other expensive metals. Crucible and furnace linings are preserved.

Famous CORNELL LADLE FLUX

Place a few ounces in bottom of ladle, then tap cupola. Metal is thoroughly cleansed, foreign impurities are easily skimmed off. Ladles are kept clean, there is less patching and increased ladle life. Metal temperatures are retained during transfer to molds.

why TUNGSTEN is used in jet engine parts



Small amounts of tungsten are used in the alloys for turbo-jet parts because tungsten increases their hardness and strength even at very high temperatures. The percentage of tungsten in high-temperature parts depends upon the physical properties desired and the service temperatures to be met. Tungsten-bearing alloys are produced in both cast and wrought forms.

For the manufacture of high-temperature alloys, ELECTROMET supplies a high-quality ferro tungsten conforming to A.S.T.M. Specification A144-39. This ferro-alloy contains 70 to 80 per cent tungsten and a maximum of 0.60 per cent carbon. It is available for immediate delivery in a crushed size of ¼ inch by down and is suitable for all electric furnace additions of tungsten in producing special heat-resistant alloys. Write for additional information on tungsten and other ELECTROMET alloys.

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Union Carbide and Carbon Corporation
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OFFICES: Birmingham • Chicago • Cleveland • Detroit
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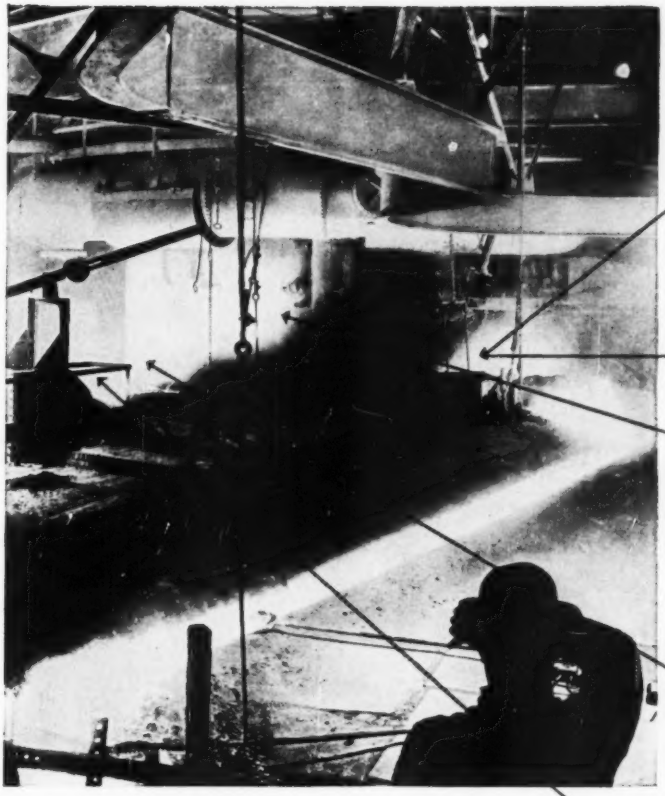
In Canada: Electro Metallurgical Company of Canada, Limited, Welland, Ontario

Electromet
TRADE-MARK
Ferro-Alloys and Metals

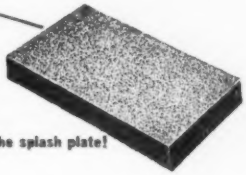
WHEREVER THE HOT STUFF HITS

USE CARBON



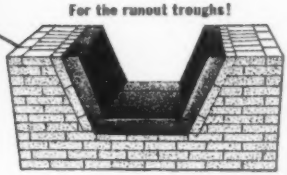
For the cinder notch liner!

For the cinder notch plug!

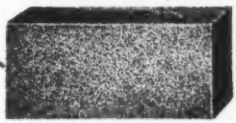


For the splash plate!

For the runout troughs!



For the skimmer plate!



● "National" carbon is now firmly established for blast furnace linings. It is being used outside the furnace as well—wherever there is contact with molten material—for the splash plate, runout troughs clear down to the ladle, skimmer plate, cinder notch liner, and cinder notch plug.

The reasons?

"National" carbon has no melting point. It is highly resistant to slag attack and thermal shock . . . not wet by molten metal . . . has a low thermal expansion . . . and maintains its mechanical strength at elevated temperatures.

Use "National" carbon inside and outside your blast furnaces and you cut down maintenance, speed up production and save money. For more information, write to National Carbon Company, Inc., Dept. AF.

The term "National" is a registered trade-mark of National Carbon Company, Inc.

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Division Sales Offices:

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These products sold in Canada by Canadian National Carbon Company, Ltd., Toronto 4

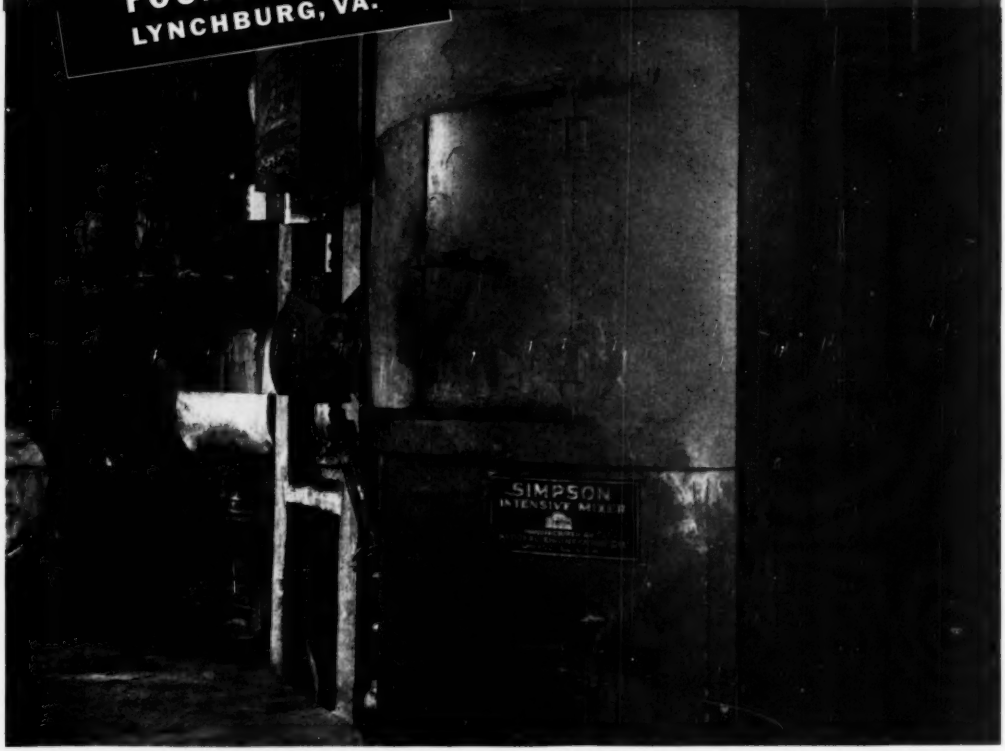
NEW No. 3 SIMPSON MIXER

Doubles Capacity

OF SAND PREPARING PLANT *at* LYNCHBURG FOUNDRY CO. LYNCHBURG, VA.

IMPROVED SURFACE FINISH AND MARKED REDUCTION IN SCRAP LOSS RESULTED WHEN A NO. 3 SIMPSON MIXER WAS RECENTLY INSTALLED TO AUGMENT CAPACITY OF EXISTING UNIT.

TO FIT INTO LAYOUT TO BEST ADVANTAGE, THE SINGLE LARGE DISCHARGE DOOR ARRANGEMENT WAS USED. THE 50 CUBIC FOOT BATCH OF SAND WEIGHING SOME 3300 LBS. IS DISCHARGED IN 13 SECONDS.



SIMPSON Intensive MIXERS

SIMPSON MIXERS WILL HELP YOU TO IMPROVE YOUR PRODUCT AND REDUCE COSTS. YOUR NATIONAL ENGINEER WILL BE GLAD TO ASSIST IN PLANNING THE INSTALLATION.

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Manufacturers and Selling Agents for Continental European Countries—The George Fischer Steel & Iron Works, Schaffhausen, Switzerland. For the British Possessions, Excluding Canada and Australia—August's Limited, Halifax, England. For Canada—Dominion Engineering Co., Ltd., Montreal, Canada. For Australia and New Zealand—Gibson, Battle & Co., Pty., Ltd., Sydney, Australia

? PRICE PER PIECE ? PRICE PER POUND ?

KNOWING FOUNDRY COSTS is never so important as in times of keen competition. Like the rest of the business world, the foundry industry is noting a transition from a sellers' to a buyers' market. And the old bugaboo "price per pound"—which the A.F.S. Foundry Cost Committee has fought for years—is entering into casting purchase discussions more and more.

Desire to maintain tonnage for tonnage's sake and lack of authentic and realistic cost figures has panicked some foundrymen into contracting for work they cannot afford to perform.

Smart foundry operation demands that the very best combination of men, materials, machines and methods be used. Choices of the last three are reported constantly in the foundry technical literature. Sound foundry costing tells the foundryman when he is using existing facilities to best advantage and gives him a basis for evaluating any changes he may contemplate making.

A good foundry cost system of the type frequently recommended and detailed in A.F.S. literature helps a foundryman decide which foundry technique is most economical. It tells him which pieces of equipment are outmoded and should be replaced. It helps him go well beyond first cost of machines and materials in analyzing their value.

It was in the April, 1946, issue of AMERICAN FOUNDRYMAN (pages 136-138) that R. L. Lee, Grede Foundries, Inc., Milwaukee—long-time chairman of the A.F.S. Foundry Cost Committee—discussed the merits of "price per piece" and the demerits of "price per pound." The advantages of "price per piece" to both consumer and producer are great enough to eliminate the "price per pound" policy from consideration, according to the article.

Citing examples, Lee showed conclusively that selling castings on a pound basis can lead to a considerable loss if the foundryman underestimates the weight of the casting. If he overestimates the weight he makes a large profit and penalizes and may eventually alienate the customer. Neither is to the advantage of the foundryman and both can be eliminated by calculating costs on a piece instead of a pound basis.

A foundryman who has many customers and a high output but who sells at a loss cannot long remain in business. Nor can he continue to operate without customers driven away by excessive costs.

During the current lull in business activity, foundrymen should overhaul their cost systems. Using realistic cost figures they can revamp their operations, taking advantage of the wealth of technical and operating data in the foundry literature. Then they will be able to quote reasonable prices, keep customers and continue to operate satisfactorily.

(A bibliography of foundry cost information published by the American Foundrymen's Society during the past ten years is available on request.) —*Editor.*

CHAPTER OFFICERS HOLD

(Top, left) A.F.S. President-Elect Edwin W. Horlebein, Chairman, opens the two-day Conference. Seated at speakers' table are, left to right: Vice-President-Elect Walton L. Woody, President W. B. Wallis, Secretary-Treasurer Wm. W. Maloney and Technical Director S. C. Massari. (Top, right) Left to right: Program Chairman Jack W. Giddens, Central Indiana; Program Chairman Stanley H. Davis, Western Michigan; Program Chairman M. E. Rollman, Cincinnati District; and Secretary George J. Biddle, Chicago, get acquainted. (Below, left) Long-distance travelers to the Conference included, left to right: Chairman Fernando Gonzalez V. and Program Chairman N. S. Covacevich of Mexico City; Program Chairman John Russo of Northern California; Program Chairman L. P. Young of British Columbia; and Chairman Jack H. King, Ontario; (Below, right) New Yorkers J. F. Livingston, Chairman, Central New York; Chairman John R. Wark and Program Chairman A. A. Diebold of Western New York Chapter examine Conference exhibits.

SIXTH ANNUAL CONFERENCE

OVER 80 A.F.S. CHAPTER OFFICERS met with national officers and staff members for the Sixth Annual Chapter Officers Conference, June 30-July 1, at the Stevens Hotel, Chicago. Purpose of the two-day meeting was to give chapter officers a better background on Society problems and operations, and to discuss chapter programs, membership development, the A.F.S. technical program, AMERICAN FOUNDRYMAN, and foundry education.

Surprise attendant at this year's Conference was W. W. Eichenberger, Milwaukee Foundry Equipment Co., Port Royal, Pa., representing the proposed Central Pennsylvania Chapter. The embryo chapter is expected to have headquarters at Pennsylvania State College, State College, Pa., and will include foundries in the surrounding territory.

Presiding at the Conference was President-Elect E. W. Horlebein, Gibson & Kirk Co., Baltimore, Md. Official guests and speakers included: President W. B. Wallis, Pittsburgh Lectromelt Furnace Corp., Pittsburgh; Vice-President-Elect Walton L. Woody, National Malleable & Steel Castings Co., Cleveland; Director W. J. MacNeill, Dayton Malleable Iron Co., Dayton, Ohio; Director-Elect F. G. Sefing, International Nickel Co., New York; George K. Dreher, executive director, Foundry Educational Foundation, Cleveland; and E. A. McFaul, Midwest Institute.

Following opening of the Conference by President-Elect Horlebein, President Wallis welcomed the group and gave a brief résumé of the origin, objects and fundamental purposes of the Society. A discussion on the CHAPTER MANUAL, now under revision, was led by Secretary-Treasurer Wm. W. Maloney. "Breaking the Ice," an audience participation program designed to help chapter delegates get a better idea of how to conduct their meetings and stimulate interest among the attendants was conducted by Mr. McFaul.

Following a buffet lunch, the motion picture, "Fluid Flow in Transparent Molds," developed on the Aluminum and Magnesium Division Research project was shown. First viewed at this year's Annual A.F.S. Convention, the film was enthusiastically acclaimed and a number of chapter officers immediately booked it for showing at meetings during the coming year.

Program building was described by Conference Chairman Horlebein, Secretary-Treasurer Maloney and Technical Director S. C. Massari.

The afternoon session closed with Herbert F. Scobie, editor, AMERICAN FOUNDRYMAN, discussing new features of "The Foundrymen's *OWN* Magazine" introduced during the past year. He also explained how chapters and Society members can make their magazine serve them better.

Highlight of the Conference Dinner which ended the first day of activity was the humorous talk, "With Your Hat in Your Hand," presented by Mr. McFaul.

Second day's sessions started with a discussion of A.F.S. technical activities led by Technical Director Massari. He explained how the national committees are organized and how they function, discussed the Society's research program and told how chapters can play a more important part in the technical work.

Membership matters, dues proration and an outline of membership processing in the National Office were explained by Promotion Manager Terry Koeller. Director-Elect F. G. Sefing led off a series of talks on educational programs by outlining the work of A.F.S. during the past few years with special emphasis on youth encouragement. National Director W. J. MacNeill described a successful in-plant training program for engineering college graduates. A preview of the 1950 A.F.S. Apprentice Contest was given by Technical Assistant Jos. E. Foster.

In a luncheon talk, George K. Dreher of FEF rounded out the educational discussion by describing the Foundation's activities the past two years.

The Conference closed with the popular session, The Shakeout, a free-for-all during which questions on any subject are freely asked and answered.

The following chapter officers attended the Sixth Annual Chapter Officers Conference. Most of the program chairmen listed are also vice-chairmen of their respective chapters:

BIRMINGHAM—Chairman C. P. Caldwell, Caldwell Foundry & Machine Co., and Secretary-Treasurer Fred K. Brown, Adams, Rowe and Norman, Inc., Birmingham, Ala.

BRITISH COLUMBIA—Chairman J. A. Dickson, Dickson Foundry Co., and Program Chairman L. P. Young, A-1 Steel & Iron Foundry Ltd., Vancouver, B. C., Can.

CANTON DISTRICT—Chairman Geo. M. Biggert, United Engineering & Foundry Co., Canton, Ohio, and Program Chairman Thomas W. Harvey, Pitcairn Co., Pittsburgh Valve & Fitting Div., Barberton, Ohio.

CENTRAL ILLINOIS—Chairman Chas. W. Bucklar, Jr., Superior Foundry Co., E. Peoria, Ill., and Program Chairman W. G. Schuller, Caterpillar Tractor Co., Peoria, Ill.

CENTRAL INDIANA—Chairman S. Franklin Swain, Golden Foundry Co., Columbus, Ind., and Program Chairman J. W. Giddens, International Harvester Co., Indianapolis, Ind.

Secretary-Treasurer Lillian K. Polzin, Twin City Chapter, first woman delegate to the Chapter Officers' Conference, is welcomed by President-Elect Horlebein.

CENTRAL MICHIGAN—Chairman Fitz Coghlin, Jr., Albion Malleable Iron Co., Albion, Mich., and Program Chairman Donald Gilchrist, Foundries Materials Co., Fremont, Ind.

CENTRAL NEW YORK—Chairman J. F. Livingston, Crouse-Hinds Co., Syracuse, N. Y., and Program Chairman David Dudgeon, Jr., Utica Radiator Corp., Utica, N. Y.

CENTRAL OHIO—Chairman W. L. Deutsch, Columbus Malleable Iron Co., Program Chairman J. Gray Lummis, A. P. Green Fire Brick Co., and Secretary D. E. Krause, Gray Iron Research Institute, Columbus, Ohio.

CHESAPEAKE—Chairman J. B. Mentzer, Wood-Embly Brass Co., Waynesboro, Pa., and Program Chairman A. A. Hochrein, American Smelting & Refining Co., Baltimore, Md.

CHICAGO—Chairman W. D. McMillan, International Harvester Co., Chicago, Program Chairman A. W. Gregg, Whiting Corp., Harvey, Ill., and Secretary-Treasurer G. J. Biddle, Illinois Clay Products Co., Chicago.

CINCINNATI—Chairman W. J. Klayer, Aluminum Industries, Inc., Cincinnati, and Program Chairman M. E. Rollman, Cincinnati Milling Machine Co., Cincinnati.

DETROIT—Chairman R. J. Wilcox, Michigan Steel Casting Co., and Secretary Julian N. Phelps, Vanadium Corp. of America, Detroit.

EASTERN CANADA—Vice-Chairman L. Guilmette, Canadian Foundry Supplies & Equip. Ltd., Montreal, Que., and Secretary J. G. Hunt, Dominion Engineering Works Ltd., Lachine, Que., Can.

EASTERN NEW YORK—Chairman Kenneth F. Echard, Eddy Valve Co., Waterford, N. Y., and Program Chairman Jasper N. Wheeler, Wheeler Bros. Brass Foundry, Troy, N. Y.

METROPOLITAN—Chairman T. J. Wood, American Brake Shoe Co., Mahwah, N. J., and Program Chairman D. S. Yeomans, G. F. Pettinos, Inc., E. Orange, N. J.

MEXICO CITY—Chairman Fernando Gonzalez V., consultant, and Program Chairman N. S. Covacevich, Foundry Div., La Consolidada S. A., Mexico, D.F., Mexico.

ONTARIO—Chairman J. H. King, Werner G. Smith Ltd., Toronto, Ont., and Vice-Chairman M. N. Tallman, A. H. Tallman Bronze Co. Ltd., Hamilton, Ont.

OREGON—Vice-Chairman James T. Brodigan, Columbia Steel Casting Co., and Program Chairman J. Goehler, Central Brass & Iron Foundry, Portland, Ore.

PHILADELPHIA—Chairman W. A. Morley, Olney Foundry Div., Link-Belt Co., and Program Chairman C. B. Jenni, General Steel Castings Corp., Philadelphia.

QUAD CITY—Secretary-Treasurer C. R. Marthens, Marthens Co., and Program Chairman H. A. Rasmussen, General Pattern Corp., Moline, Ill.

ROCHESTER—Program Chairman Kenneth R. Proud, Anstice Co., Inc., and Secretary Leon C. Kimpal, Rochester Gas & Electric Corp., Rochester, N. Y.

SAGINAW VALLEY—Program Chairman Howard H. Wilder, Eaton Mfg. Co., Foundry Div., Vassar, Mich.

ST. LOUIS DISTRICT—Chairman Geo. N. Shepherd, Sterling Steel Casting Co., E. St. Louis, Ill., and Program Chairman John H. Williamson, M. A. Bell Co., St. Louis.

SOUTHERN CALIFORNIA—Chairman Earle D. Shomaker, Kay-Brunner Steel Products, Inc., Alhambra, Calif., and Program Chairman John E. Wilson, Climax Molybdenum Co., Los Angeles, Calif.

TENNESSEE—Chairman K. L. Landgrebe, Jr., Foundry Div., Wheland Co., and Vice-Chairman P. L. Arnold, U. S. Pipe & Foundry Co., Chattanooga, Tenn.

TEXAS—Chairman Chas. R. McGrail, Texaloy Foundry Co., San Antonio, Texas, and Program Chairman W. H. Lyne, Hughes Tool Co., Houston, Texas.

TIMBERLINE—Vice-Chairman John W. Horner, Jr., Slack-Horner Brass Mfg. Co., and Secretary James E. Schmuck, Rotary Steel Castings Co., Denver.

TRI-STATE—Chairman C. A. McNamara, Jr., Big Four Foundry Co., Inc., Tulsa, Okla., and Director F. E. Fogg, Acme Foundry & Machine Co., Coffeyville, Kan.

Chairman T. J. Wood of the Metropolitan Chapter, one of more than 100 registrants at the Sixth Annual A.F.S. Chapter Officers Conference, receives his badge while fellow officers look on. Left to right are: Program Chairman Frank P. Volgstadt, Northwestern Pennsylvania; Chairman Kenneth F. Echard, Eastern New York; Secretary James E. Schmuck, and Vice-Chairman John W. Horner, Jr., Timberline; Program Chairman Jasper N. Wheeler, Eastern N. Y.; and Program Chairman D. S. Yeomans, Metropolitan.

MICHIANA—Chairman V. S. Spears, American Wheelabrator & Equip. Corp., Mishawaka, Ind., and Vice-Chairman Wm. G. Ferrell, Auto Specialties Mfg. Co., St. Joseph, Mich.

MO-KAN—Chairman J. T. Westwood, Jr., Blue Valley Foundry, and Program Chairman Clarence W. Culbertson, M. W. Warren Coke Co., Kansas City, Mo.

NORTHEASTERN OHIO—Chairman Wm. G. Gude, Penton Publishing Co., and Program Chairman Fred J. Pfarr, Lake City Malleable Co., Cleveland.

NORTHERN CALIFORNIA—Chairman J. L. Francis, Vulcan Steel Foundry Co., and Program Chairman John R. Russo, Russo Foundry Equip. Co., Oakland, Calif.

NORTHERN ILLINOIS & SOUTHERN WISCONSIN—Chairman Lester C. Fill, Geo. D. Roper Corp., and Program Chairman F. W. Thayer, Gunite Foundries Corp., Rockford, Ill.

NORTHWESTERN PA.—Treasurer Fred J. Carlson, Weil-McLain Co., and Program Chairman Frank P. Volgstadt, Griswold Mfg. Co., Erie, Pa.

TWIN CITY—Chairman Franklin A. Austin, Crown Iron Works Co., Minneapolis, Program Chairman S. L. Cameron, Jr., Valley Iron Works, Inc., St. Paul, Minn., and Secretary-Treasurer Lillian K. Polzin, Manufacturers' Secretariat, Chamber of Commerce, Minneapolis.

WASHINGTON—Chairman Edward D. Boyle, Puget Sound Naval Shipyard, Bremerton, Wash., and Program Chairman J. F. Dolansky, Griffin Wheel Co., So. Tacoma, Wash.

WESTERN MICHIGAN—Chairman C. N. Jacobson, Dake Engine Co., Grand Haven, Mich., and Program Chairman S. H. Davis, Campbell, Wyant & Cannon Fdry. Co., Muskegon, Mich.

WESTERN NEW YORK—Chairman John R. Wark, Queen City Sand & Supply Co., and Program Chairman A. A. Diebold, Atlas Steel Castings Co., Buffalo.

WISCONSIN—Chairman R. C. Woodward, Bucyrus-Erie Co., So. Milwaukee, Program Chairman J. G. Risney, Risney Foundry Equipment Co., Milwaukee, and Secretary Geo. E. Tisdale, Zenith Foundry Co., West Allis, Wis.

Division and committee officers attending this year's Technical Correlation Committee meeting were (starting left): A. F. Pfeiffer, Allis-Chalmers Mfg. Co., Milwaukee; Leonard F. Tucker, City Pattern & Foundry Co., South Bend, Ind.; F. J. Walls, International Nickel Co., Detroit; Technical Director S. C. Massari; Technical Assistant Jos. E. Foster; Secretary-Treasurer Wm. W. Maloney; R. G. McElwee, Vanadium Corp. of America, Detroit; A. W. Gregg, Whiting Corp., Harvey, Ill.; Charles Locke, Armour Research Foundation, Chicago; L. H. Hahn, Sivyer Steel Castings Co., Chicago; James Thomson, Continental Foundry & Machine Co., East Chicago, Ind.; Walter E. Sicha, Aluminum Co. of America, Cleveland; David Basch, Almin, Ltd., of Great Britain, Schenectady, N.Y.; Walter Bonsack, Apex Smelting Co., Cleveland; Erwin G. Tetzlaff, Pelton Steel Casting Co., Milwaukee; Robert P. Schauss, Illinois Clay Products Co., Chicago; Karl J. Jacobson, Griffin Wheel Co., Chicago; Walter W. Edens, Badger Brass & Aluminum Foundry, Milwaukee; and George P. Halliwell, H. Kramer & Co., Chicago. A.F.S. technical programs and policies were discussed.

TECHNICAL CORRELATION COMMITTEE MEETS

Announce Division And General Interest Committee Heads

TECHNICAL CORRELATION COMMITTEE members held their annual meeting June 13 at the LaSalle Hotel in Chicago. Reviewing technical activities of A.F.S. for the past year, they heard reports of the eight division and the general interest committee chairmen. As the technical policy making body of the Society, the Committee established a line of activity to be followed by the organization's more than 500 national committee members during the coming year.

Presiding at the meeting were Past President F. J. Walls, International Nickel Co., Detroit, and Technical Director S. C. Massari.

Division and general interest committee chairman to serve for the next two years have been elected by letter ballot or at business meetings of the respective groups held during the 53rd Annual A.F.S. Convention in St. Louis, May 2-5. Customarily named in the odd years, the division and committee chairmen will guide A.F.S. technical activities in their fields and participate in overall coordination of the work as members of the Technical Correlation Committee.

New chairman of the Aluminum and Magnesium Division is Walter E. Sicha, Aluminum Company of America, Cleveland, who replaces retiring chairman Walter Bonsack, Apex Smelting Co., Cleveland, Hiram Brown, Solar Aircraft Co., Des Moines, Iowa, will continue as vice-chairman of the division, a position to which he was appointed late in 1948.

Heading the Brass and Bronze Division are George P. Halliwell, H. Kramer & Co., Chicago, and Arthur K. Higgins, Allis-Chalmers Mfg. Co., Milwaukee. Mr. Halliwell moved up from the vice-chairmanship to the chairmanship, formerly held by Walter W. Edens, Badger Brass & Aluminum Foundry Co., Milwaukee.

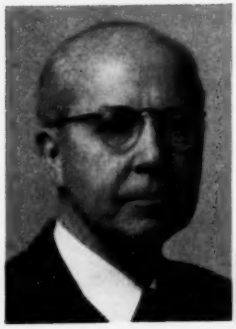
A. W. Gregg, Whiting Corp., Harvey, Ill., former vice-chairman of the Educational Division, has replaced Fred G. Sefing, International Nickel Co., New York, as chairman of that division. Mr. Sefing was elected a National Director at this year's Convention. Vice-chairman for the Educational Division is Ben D. Claffey, Acme Aluminum Alloys, Inc., Dayton, Ohio. A former National Director of A.F.S., Mr. Claffey has

L. F. Tucker

R. P. Schauss

A. S. Klopf

B. D. Claffey



G. E. Bean

James Thomson

just been elected vice-president of the Foundry Educational Foundation.

Chairman and vice-chairman of the Gray Iron Division for the coming two-year period are V. A. Crosby, Climax Molybdenum Co., Detroit, formerly vice-chairman, and W. W. Levi, Lynchburg Foundry Co., Radford, Va. R. G. McElwee, Vanadium Corporation of America, Detroit, retired as chairman of the division; he will continue as chairman of the Cupola Research Committee.

Heading the Malleable Division is George E. Bean, Eastern Malleable Iron Co., Wilmington, Del., who replaces Leon J. Wise, Chicago Malleable Castings Co., Chicago. Robert P. Schauss, Illinois Clay Products Co., Chicago, fills the post of vice-chairman, a position held during the past four years by W. B. McFerrin, Electro Metallurgical Co., Detroit.

Changes in the Pattern Division have made Leonard F. Tucker, City Pattern & Foundry Co., South Bend, Ind., the new chairman of the group. He was vice-chairman the past two years. New vice-chairman is H. K. Swanson, Swanson Pattern & Model Works, East Chicago, Ind.

Officers for the Sand Division did not change. Chairman will again be H. Ries, Ithaca, N. Y. P. E. Kyle, Cornell University, Ithaca, will continue to serve as vice-chairman.

In the Steel Division, Charles Locke, Armour Research Foundation, Chicago, is chairman after serving the past two years as vice-chairman. Replacing him is the new vice-chairman of the division Ray H. Frank, Bonney-Floyd Steel Casting Co., Columbus, Ohio.

During 1948-49 one new general interest committee was formed, a committee was reactivated, and one committee changed its name. New name of the former Job Evaluation & Time Study Committee is Time Study & Methods, a designation committee members believe more nearly describes their present activities. Chairman of the committee is Erwin G. Tetzlaff, Pelton Steel Casting Co., Milwaukee.

Heading the reactivated Safety & Hygiene Committee is Lee C. Wilson of Reading, Pa., President of A.F.S. during the 1943-44 term.

Newest general interest committee is the Plaster Mold Casting Committee. Chairman is David Basch, consultant, Schenectady, New York.

Most of the general interest committees will have the same chairmen during the coming two years. Continuing in office for their respective committees are: Chemical Analysis—Karl J. Jacobson, Griffin Wheel Co., Chicago; Fluidity Testing—Howard F. Taylor, Massachusetts Institute of Technology, Cambridge; Foundry Cost—Ralph L. Lee, Grede Foundries Inc., Milwaukee; Heat Transfer—H. A. Schwartz, National Malleable & Steel Castings Co., Cleveland; Plant & Plant Equipment—James Thomson, Continental Foundry & Machine Co., East Chicago, Ind.; Precision Investment Casting—Robert Neiman, Whip-Mix Corp., Louisville, Ky.; and Refractories—A. S. Klopf, Western Foundry Co., Chicago.

H. F. Taylor

G. P. Halliwell

E. G. Tetzlaff

K. J. Jacobson

R. H. Frank

Lee C. Wilson

W. E. Sicha

A. K. Higgins

Hiram Brown

W. W. Levi

A. W. Gregg

V. A. Crosby

Robert Neiman

C. Locke

H. K. Swanson

R. L. Lee

P. E. Kyle

H. Ries

H. A. Schwartz

David Basch

HISTORY'S first great writer on the art of casting metals lived in Sixteenth Century Italy, at a time and place when the world was slowly emerging from a thousand years of darkness, superstition and ignorance. It is to such men as Vannoccio Biringuccio of Siena, the "Father of the Foundry Industry," the first man to write in detail on foundry practice, that the world owes a debt of gratitude for establishing the basic scientific tenets upon which modern industrial methods are founded.

Mario Olivo
President
Italian Foundrymen's Association
Milan, Italy

Wrote First Book on Casting

A contemporary of such master artists and scientists as Leonardo Da Vinci and Benvenuto Cellini, Biringuccio was world-reknowned as a man of science. His treatise, *De La Pirotechnia* (Pyrotechnics), the first known work in which the art of casting metals is described in detail, was widely circulated for three centuries after his death.

Born in Siena, Italy, on October 20, 1480, the son of an architect, Vannochio Biringuccio spent his youth traveling extensively in Italy and Germany, diligently acquiring knowledge of metals and experimenting in their melting and casting.

In Siena, in Florence and in Rome, Biringuccio developed alloys and means of casting them, coined money, cast artillery pieces and bells of bronze and lead, and managed gunpowder factories and mines.

Following the publication of *De La Pirotechnia*, Biringuccio achieved wide recognition among contemporary scientists. The German metallurgist, Agricola—or Bauer, as he is sometimes known—termed the man from Siena "a most cultured man and technical expert," and in his work, *De Re Metallica*, admitted that he owed a great deal to Biringuccio.

Benvenuto Cellini, in whose biography there is a detailed description of the casting of the famous statue, "Perseus," owed much of his art to Biringuccio. Many of Cellini's descriptions of the casting of bronze sculpture were borrowed from Biringuccio.

During the sixteenth century, man believed in the transmutation of metals, solely for the ultimate purpose of converting them all into gold, and such a belief was held up to the end of the eighteenth century. Biringuccio attacked this illusion and made fun of the alchemists.

Biringuccio, an early advocate of experimental methods, believed only in his own experiments, in which he employed a scale constantly to establish weight relationships in the compounding of alloys. Three centuries later, Biringuccio's methods were to form the basis of modern chemistry. The work of this great Italian scientist was of primary value and importance because he was a technical expert who wrote only of the results of the work of his own hands, and of what he saw with his own eyes.

Described Rigors of Foundry Work

In his *De La Pirotechnia*, Biringuccio devotes Books VI, VII, and VIII to the art of casting, which, he says, is "reducing metals to their ultimate perfection." The Master of Siena points out that the casting art is not an easy one, nor a grateful one because the person who practices it "is required to have great endurance of mind as well as of body, even though he himself may be a great genius of the art." However, he continues, such labors and inconveniences "are borne with such pleasure and to such an extent that those who practice the said art are as if they are trapped by it and cannot escape." Biringuccio writes that he had many times thought of giving up foundry work because of the extraordinary difficulties and physically fatiguing requirements, but he never took such a step.

A master of the art of writing as well as of science, Biringuccio said "If one always uses diligence to carry out perfect means, one will never fail in one's

ultimate purpose." Among the reasons for lack of success given in his treatise are "the desire to shorten the time or to escape the expense or the hard work involved" in casting metals and "placing too much confidence in the work of other people."

In another chapter, Biringuccio discusses molding sands, stating that they are "lean or fat, sandy or argillaceous." The sandy earths, he said, do not have cohesion, but on the other hand the fatty earths are very strong, except that in drying they shrink and break. Good earths, Biringuccio wrote, must be those which are neither too fat nor too lean, and the best earths are those obtained by mixing natural earths."

Preparing Early Molding Sands

Porosity is imparted to these earths by the addition of a certain quantity of organic substances. the author states, among which are "cloth clippings, manure and cut straw, and the working is done by hand on a table by means of an iron rod and the addition of water."

Ingenious is Biringuccio's definition of a pattern, "each hole makes a full part and each full part makes a hole according to the nature of the original model." The five centuries of foundry practice and writings since his death in 1539, have not given us a better definition of a pattern.

That green sand molding was known to Biringuccio is evidenced in the fourth chapter of Book VIII, in which he speaks of "methods of making the powder for casting any metal in the cold" without drying the mold. Molding sand, he wrote, is obtained by mixing "natural yellow earth with very fine and very well washed river sand which has first been reheated in the furnace."

This was done, evidently, for elimination of organic substances, and the addition of such binder substances as flour or manure and urine. For the purpose of imparting a better appearance to the castings, forms thus obtained were smoked in "tormentina" (resin) or tallow flames.

Biringuccio also gives the composition of a molding sand which he calls "trajectory powder," composed of "river sand, washed river mud and similar earths which have a natural thin and lean grain of which a large quantity is formed artificially." It is evident that synthetic molding sands, consisting of siliceous and argillaceous sands are not an invention of modern times.

In describing the lost wax method of casting, Biringuccio points out that the core must first be covered with wax, and finished in accordance with the rules of the art. After having arranged the necessary supports for holding the pattern, the various melting attachments or "branches of the casting" are united in a great trunk through which the "melting material" shall enter the form and fatty earth is spread in multiple layers to a thickness sufficient to support "the weight and impact of the molten material."

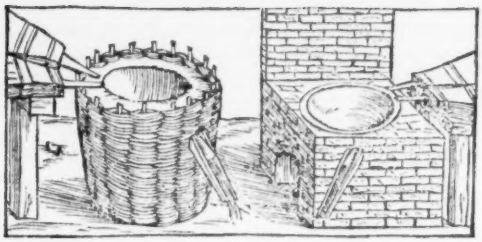
Casting Artillery Pieces

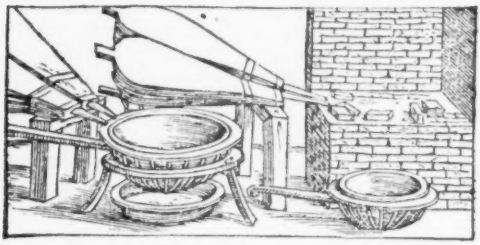
Biringuccio adds that it is possible "to remove the wax with coal fire, so that the mold remains empty." The lost wax process is applied by him to all artistic castings, such as brass or bronze ornaments and statues, low and high reliefs, and objects of complicated design, especially those showing cavities or recesses.

Regarding molding forms for casting artillery, Biringuccio instructs that a wooden mold be made that can be rotated and which is provided with a head or balloon "so that bronze may be charged." After the mold is coated with tallow or wax, the hole is then covered with clay or earth in successive layers reinforced with iron wire and bars for the purpose of "making the form solid." After drying, the mold is taken away "with

"That first true foundryman, Vannoccio Biringuccio (1480-1539) will stand for all time as the 'father of the foundry industry'. Head of the Papal foundry in Rome, he is the first man known to have set down foundry practice in great detail. His clarity of analysis, together with a common-sense, practical approach, mark him as an accomplished artisan. To be convinced that Biringuccio knew the foundry business it is only necessary to examine his statement that achievement in the art of casting 'lies in three principal actions. One is making and arranging the molds well; the next is smelting and liquefying the materials of the metals well; and the third is making the composition of their associations according to the results you wish to have.' . . . Perhaps some day proper credit and honor may be done this earliest of articulate foundrymen."—Bruce L. Simpson in *Development of the Metal Castings Industry.*

Benvenuto Cellini, renowned sculptor of the Italian Renaissance, owed much of his foundry genius, as exhibited in his famous Perseus, *to the foundry principles laid down by his contemporary, Biringuccio.*





Shown in the old woodcuts above are melting processes in Biringuccio's Sixteenth Century Italy. (Top) Melting in the basket and in the hearth, both arranged for bottom tapping. (Bottom) Ladle melting.

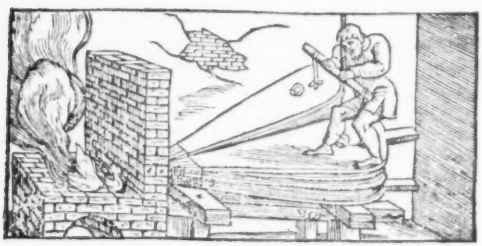
pulleys or manpower," Biringuccio's treatise states.

Biringuccio describes the manufacture of cores on a lathe, without which "the cavity cannot be made where the powder must be placed." The cores, he states, must be sufficiently strong, but not too compact for easy removal from the casting. This was obtained by coating the iron casing with straw and now and then with successive layers of fatty earth (clay).

Describes Casting of Guns

The description of the casting of sixteenth century artillery pieces continues by stating that the mold thus obtained must be placed in the ground or covered with earth to enable it to withstand the heat of the molten metal poured into it through a canal or channel leading from an open-hearth furnace. In describing this process, Biringuccio sets forth bits of advice gleaned from his own experiences . . . "do not use earths which contain shells" (a sure indication of the presence of alkaline earth carbonates) . . . and to feed

Below: Smelting metal in Sixteenth Century Italy using bellows operated directly by a man's weight.

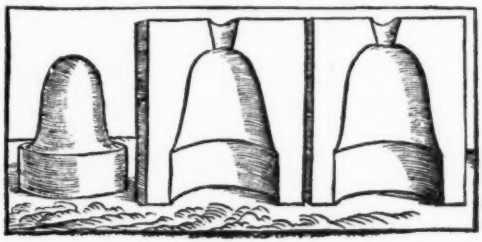


the risers of castings "with bronze richer in tin."

Five chapters of *De La Pirotechnia* are devoted to descriptions of systems for the shaping and melting of bells and are illustrated with clear copper engravings. It is interesting to note the manner in which the sizes and shapes of bells affect their tonal qualities. Biringuccio also describes a special open hearth furnace for the soldering of cracked bells.

Early Melting Processes

Seven chapters of *De La Pirotechnia* cover "the ways and methods of fusions of metals," in which Biringuccio attributes the greatest importance to the construction of furnaces, fuels, various systems of bellows, and the art of making alloys. In other books of the treatise, the manufacture of crucibles and the use of fluxes are described in considerable detail.



(Top) These were the types of chaplets used in Fifteenth Century Italy for supporting cores in gun molds. (Bottom) Green sand core and mold used in casting small bells about the time of Biringuccio.

Among the melting furnaces described by Biringuccio is the open hearth, of whose dimensions he writes in detail, illustrating his descriptions with engravings. Cupola-type furnaces of the sixteenth century consisted of a shaft of hemisphered shape, which was filled with coal mixed with the metal to be melted, and blown with wind from a bellows. The molten metal gathered at the bottom of the shaft, which was tapped by opening a hole at intervals. For the purpose of increasing the quantity of molten metal, the edges of the shaft or hearth were often raised with masonry made of bricks. We can recognize here a distant ancestor of the cupola furnace in use today.

Another chapter describes a process of melting cast iron for making "iron balls to be shot by artillery." These iron balls, according to Biringuccio, were introduced in Italy by the soldiers of Charles, King of France, in the war against Ferdinand in 1495.

Cast iron was at that time obtained from charges of iron scrap which *carburized* in the melting, and Biringuccio discovered that the best mechanical quality was obtained when the iron was pure, but on the other hand he found that the addition of antimony or arsenic made melting easier, but produced a more fragile alloy.

Regarding the melting of lesser quantities of metal, the Master of Siena describes various crucible furnaces with both natural and forced draughts. Several engravings from his book are reproduced here.

Limitations of space do not permit a complete summary of the works of Biringuccio of Siena, but his work, *De La Pirotechnia*, was translated by Cyril Smith and Martha Gnudi and published by the American Institute of Mining and Metallurgical Engineers in 1942. Historically-minded foundrymen will find much of value and interest in its contents.

Editor's Note: Illustrations in this article are taken from Biringuccio's *De La Pirotechnia* and the *De Re Metallica* of Agricola, some of which are reproduced from DEVELOPMENT OF THE METAL CASTINGS INDUSTRY, by Bruce L. Simpson.

This old drawing, showing types of mediaeval blast furnaces for smelting ores, is from De Re Metallica, *by Agricola, a German contemporary of Biringuccio.*

Harry G. Lamker Dies

H. G. Lamker

NATIONAL DIRECTOR HARRY G. LAMKER died June 17. Superintendent of foundries for Wright Aeronautical Corp., Wood Ridge, N. J., since 1922, he was associated with aluminum founding continuously for over 30 years.

Born in Pittsburgh, Mr. Lamker graduated from Carnegie Institute of Technology in 1912 with a metallurgical engineering degree. He spent four years with General Electric Co. on experimental work and two years as metallurgist and foundry superintendent for Johnson Bronze Co. Before joining Wright Aeronautical Corp. he was assistant technical supervisor of Aluminum Castings Co.

Mr. Lamker was elected a National Director of the American Foundrymen's Society at the Golden Jubilee Convention in 1946 and was completing his three year term at the time of his death. He was the first representative of the Aluminum and Magnesium Division to be elected a director of A.F.S.

Return Prepublication Order Forms For 1949 *A.F.S. Transactions* Early

PREPUBLICATION ORDER FORMS for the 1949 ANNUAL TRANSACTIONS (Vol. 57) of the American Foundrymen's Society were mailed to all Society members July 1. To be a limited printing based on prepublication orders received and paid for in advance, this year's edition will be mailed approximately November 15. Prepublication price to A.F.S. members of $6.00 will be granted only if orders, including remittance, are received at A.F.S. Headquarters prior to September 30. After that date the price to members is $8.00. Nonmember price at all times is $15.00.

Sustaining and honorary members on record as of date of publication receive one copy gratis on request. Also authorized by the Board of Directors, acting on recommendation of the Publications Committee, is limitation of this year's edition of TRANSACTIONS to a clothbound edition only.

Accompanying the 1949 TRANSACTIONS order form was the latest A.F.S. publications price list and order blank for those wishing to continue to build up their home library of foundry literature. On the list of 33 publications are three popular books recently reprinted and the prize-winning DEVELOPMENT OF THE METALS CASTING INDUSTRY, foundry historical book by Bruce L. Simpson, National Engineering Co., Chicago. The three books are: HANDBOOK OF CUPOLA OPERATION, FUNDAMENTALS OF DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF EXHAUST SYSTEMS, and BIBLIOGRAPHY OF PERMANENT MOLD CASTINGS.

Symposium

NODULAR GRAPHITE CAST IRON

D. J. Reese, Metallurgist
International Nickel Co., New York

DUCTILE CAST IRON may be produced in practically any reasonably well controlled steel, gray iron or malleable iron foundry. It can be made economically, with assurance and without hazard. It may be melted and is being melted in all types of melting furnaces used in the foundry industry. This new material and cupola melting make a good team. Its engineering and physical properties are closely associated with the matrix structure; for example, the as-cast ductility of a completely ferritic matrix is high and decreases with increasing amounts of pearlite.

Any of the conventional methods for heat treating ferrous materials are applicable to ductile iron. This material is not sensitive to section size. In cast iron, for example, a 3.5 per cent carbon and 2.75 per cent silicon chemistry would be designed for very light sections, say ¼-in., and would be wholly unsuited to 2-in. or 20-in. sections, assuming of course that a quality material is desired in all sections. A ductile iron of 3.5 per cent carbon and 2.75 per cent silicon may be used in either a ¼-in. or 20-in. section.

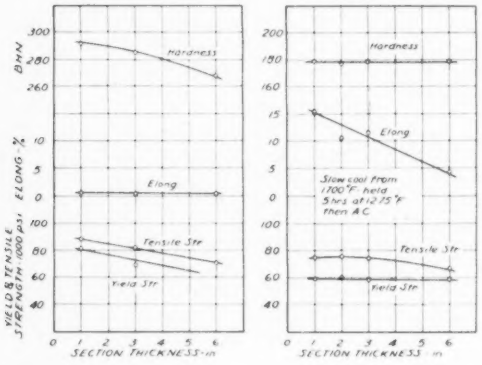
A malleable iron of 2.5 per cent carbon and 1.0 per cent silicon might well produce primary or flake graphite in 2-in. sections, while in ductile iron a much higher carbon and a much higher silicon would not produce flake graphite though the sections were many times 2 in. The engineering properties of this new material are influenced by mass. Strength and ductility are greater in 1-in. sections than in 20-in. sections. This influence of mass is approximately the same as it is in other engineering materials.

The hardness of ductile iron is about the same as for malleable iron or for cast iron with equivalent conditions of chemistry and annealing. There are some qualifications to this statement which will be developed later in the discussion. It is possible to vary the hardness of ductile iron over wide ranges.

Ductile iron is superior in machinability to malleable iron or cast iron at equivalent levels of engineering properties. This might be said in another way; the machinability of ductile iron under equivalent conditions of chemistry and treatment is superior to malleable iron or cast iron. The machinability of ductile iron is very good when the level of engineering properties is greatly in excess of the properties attainable in malleable iron or cast iron.

Sponsored jointly by the Gray Iron and Malleable Divisions of A.F.S., the symposium on "Production of Nodular Graphite Cast Iron" at the 53rd Annual Meeting of A.F.S. in St. Louis, May 2-5, 1949, drew the largest attendance, over 700, of any technical session in A.F.S. history. H. Bornstein, Deere & Co., Moline, Ill., presided; C. O. Burgess, Gray Iron Founders' Society, Cleveland, was co-chairman. The speakers were D. J. Reese, International Nickel Co., New York; O. K. Donoho, American Cast Iron Pipe Co., Birmingham; G. Vennerholm, Ford Motor Co., Dearborn, Mich.; and R. G. McElwee, Vanadium Corp. of America, Detroit.

Influence of section thickness on mechanical properties of a cupola iron of percentage composition: C, 3.27; Si, 2.40; Ni, 2.01; Mn, 0.62; P, 0.15.



The machinability of ductile iron is very good when the level of engineering properties is greatly in excess of the properties attainable in malleable iron or cast iron.

A 375 BHN ductile iron has been machined where a 275 BHN cast iron presented difficulty. A number of the ductile irons exhibited at this meeting have machined surfaces, and an examination of these surfaces will show the high quality of the finish. The exhibit includes two plates, one of flake graphite cast iron and the other of spheroidal graphite cast iron, and the superiority of the latter in the machined surface is apparent.

We have run comparative mechanical wear tests on flake graphite and spheroidal graphite irons of the same chemistry. Our observations for the amount of work we have been able to do thus far permits the statement that mechanical wear resistance on spheroidal graphite irons is at least as good as it is with flake graphite irons.

Growth tests on spheroidal carbon iron have also been conducted. In this test we heat the material to

1650 F, hold for one hour, cool to room temperature, and repeat this cycle over and over, usually 100 times. Where flake graphite irons grow appreciably and nickel-chrome alloyed flake irons grow considerably less, the spheroidal graphite irons grow still less.

Thermal Tests in Progress

Spheroidal carbon irons are on test in applications involving thermal shock, such as a die in an aluminum die casting operation, or an ingot mold in a copper refinery, and as an ingot mold for alloy steel. Although some of these parts were made in the summer of 1948 and early in 1949, they are still in service and we will not be able to appraise service performance until their service life has run its course.

Corrosion tests are underway in a wide variety of conditions, but it will not be possible to report on this study for quite some time.

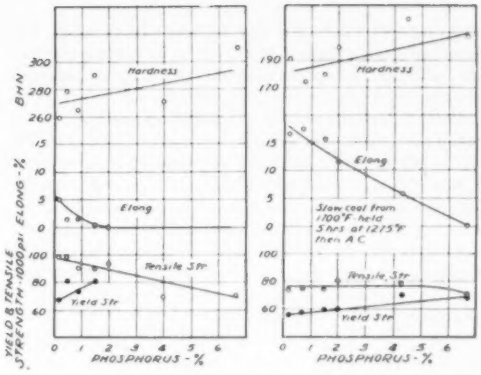
Among the materials exhibited at this meeting are:

1. Sections of 8-in. cast iron pipe with 0.42-in. wall sections of both regular flake graphite iron and of spheroidal graphite iron. These pipe have been pressure tested to destruction and data on the test are noted on the pipe. Acceptance tests on cast iron pipe require an 18,000 psi minimum tensile strength in the wall. The ductile irons approach 50,000 psi. The twisted specimens of ductile iron were made from sections machined from the spheroidal iron pipe. These pipe were made by the De Lavaud process in which metal is poured into a metal mold.

2. A piece of ductile cast iron chain is on display. This chain has been tested with a static and impact load, and photographs of the test are shown. The rod diameter of the chain is ¾-in. My only knowledge of cast iron being used for a chain was in the Revolutionary War when a cast iron chain was reported to have been put across the Hudson River at West Point to keep the British fleet from going farther up the river. The piece of chain on exhibit is not intended to suggest an application for ductile cast iron but to span that 175-year gap from Revolutionary War days to the real drama of this technological advance.

3. The tool chips exhibited are: (a) from flake graphite iron; (b) from as-cast spheroidal iron; and (c) from annealed spheroidal iron.

4. Some castings exhibited have been broken up so that they may be inspected for section variation, internal or external defects, and the appearance of the fracture. Some of these castings were made from patterns designed and used for malleable iron. Others were made from patterns designed for flake graphite cast iron.

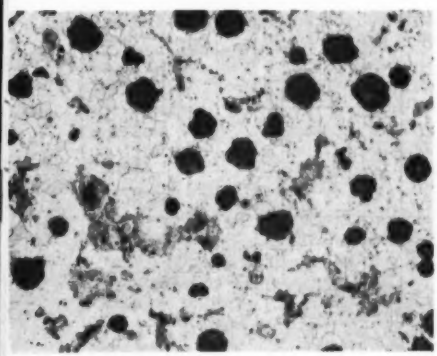


Influence of phosphorus on mechanical properties of 1-in. sections of percentage composition: C, 3.3 to 3.7; Si, 1.4 to 2.7; Mn, 0.6 to 0.8; Ni, 2.0.

We had hoped to have some parts designed for spheroidal carbon irons replacing materials produced by other industries, but the producers could not spare any at this time.

Thus far the largest amount of spheroidal iron produced in one foundry in one day is 50 tons. It would seem that this figure of 50 tons comes close to answering two questions: first, is the process reasonable in cost; and second, is the process now commercial? About the largest number of heats that any commercial foundry has made to date is 50. From the engineering point of view, this foundry advises that none of their applications of ductile cast iron have been where cast iron was used formerly; numerous applications have been made where materials processed by other industries have been used.

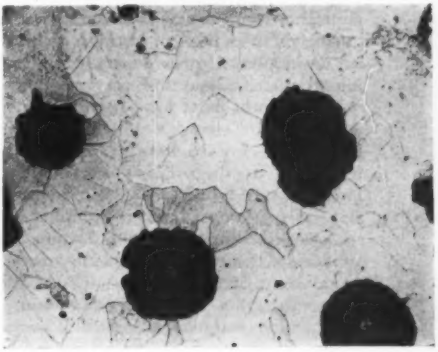
The spheroidal form of carbon may be attained by the magnesium-treatment process irrespective of the amount of phosphorous or sulphur present in the iron. The influence of phosphorous on the engineering properties of ductile iron parallels the influence of phosphorous in all ferrous metals. Highest engineer-



0.20 per cent P

Microstructures of annealed sand castings.

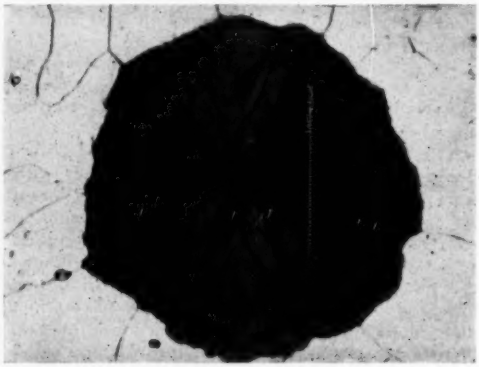
0.04 per cent P



ing properties are obtained in low phosphorous ferrous materials. Ductile iron can be produced whether the sulphur is as low as 0.025 per cent or as high as 0.25 per cent.

Ductile irons have been produced from cupola metal when the cupola charge has been made up of: (a) 100 per cent pig iron; (b) 100 per cent steel scrap; (c) 100 per cent sash-weight scrap; and (d) with a wide number of regular charges varying in amounts of pig iron, steel scrap and cast scrap. Without exception, whenever we go into a foundry to supervise and instruct in the production of magnesium-treated cast iron, we always select the lowest grade iron this foundry produces for the base iron of the process.

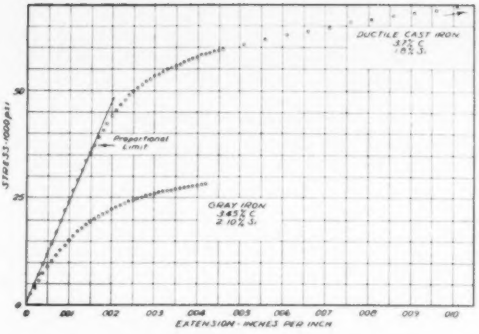
Some concern has been felt as to whether the alloy residual in foundry returns from spheroidal graphite iron production would ultimately build up in the over-all melt to an undesirable level. There need not be an introduction of alloys such as nickel, molybdenum, copper, and chromium by this process, so the problem of alloy residual in returns is not created.



Spheroidal graphite in annealed sand casting.

Introduction of the magnesium-treated cast iron process is not quite so simple as pressing a stop button on current cast iron or malleable iron production and pushing a start button on the ductile iron process. The shrinkage characteristics of ductile iron are greater than cast iron of the same chemistry, and less than malleable iron. A cast iron foundry successfully producing pressure types of castings, such as valve bodies, has developed adequate experience in gating and risering to match inspection pressure test requirements.

Ductile iron parts have been made from such patterns without change. Where the pressure test has been 100 lb on the flake graphite iron the pressure test on the ductile iron has been 900 lb. The average foundry would have to acquire some of the gating and risering experience of the foundry producing pressure work before they would become fully skilled in producing completely satisfactory component parts. As the solidification characteristics of ductile iron differ considerably from malleable iron, a sufficiently gated and risered malleable pattern might not produce sound ductile iron castings as there could be reverse



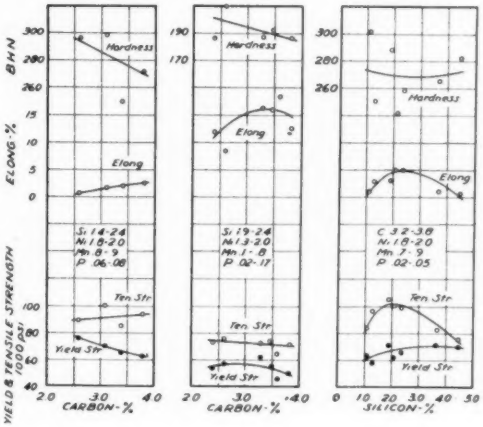
Stress-strain curves of plain gray iron (3.47 per cent C, 2.10 per cent Si) and ductile cast iron (3.7 per cent C, 1.8 per cent Si).

feeding from casting to riser. That is, some of the risering provisions for malleable would have to be removed for ductile iron.

Ductile irons do not require special molding sands. In all of the foundries that we have worked in to date, we have used whatever natural or synthetic sands they had been using for the parts and the various types of metal involved. If a foundry has been producing defective castings due to poor control over molding sands, they will also produce defective ductile iron castings. We have superimposed the magnesium-treated cast iron process without change in available facilities, man power, skills, metal distribution system, or raw materials such as furnace and ladle refractories, on the foundry's normal methods of operation.

What are the impacts of this development on the foundry industry? In 1948 the ferrous foundry industry produced approximately 15½ million product tons of component parts in steel, malleable iron and cast iron. In round figures, the steel industry produced 61½ million product tons of finished and semi-finished

Influence of carbon and silicon on mechanical properties of 1-in. sections.



steel. The total product tons of the foundry and steel industries of ferrous materials would be something like 77 million product tons, of which 20 per cent represents foundry and 80 per cent industry production.

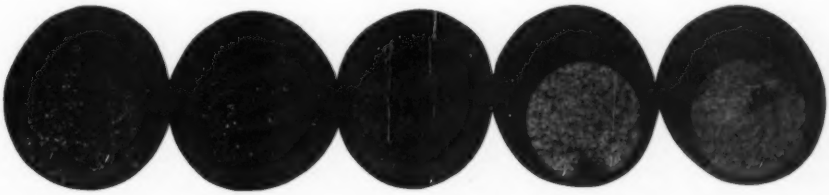
If America were to remain static in its industrial growth, one could forecast that the 20 per cent foundry portion of this huge industrial pie would increase, while the 80 per cent steel portion would decrease. Note that a small shift of 1 or 2 per cent toward the foundry would mean as much as 1½ million tons. However, there are two more important factors to consider; first, America is not a static industrial nation and the 77 million product tons of ferrous materials produced last year will be dwarfed in some period still ahead, and second, when a new engineering material emerges from the mind of man and fits the pocketbook of the ultimate consumer new horizons are established for industrial America.

When steel, synthetic rubber, shatterproof glass, plastics, aluminum, magnesium and a host of other engineering materials became available, they did not replace the older materials—they opened up new horizons of opportunity and most generally carried the use levels of the older materials to still higher levels.

The basic plan for blackheart malleable iron has been concerned with: (a) rigid adherence to chemistry requirements close to 2.5 per cent carbon and 1.0 per cent silicon; (b) sections limited to producing a white iron in sand molds; (c) low yields of salable product per unit of hot metal produced; (d) high percentages of man power, expense and floor space required to process after casting; (e) large amounts of capital tied up in materials in process; and (f) prolonged deliveries which are often out of phase with high speed industrial operations. Magnesium-treated cast iron procedures can modify all these factors appreciably.

Malleable Foundry Industry Production

Although I have never seen a statistical summary of the number of component parts made annually in the malleable foundry industry, I would estimate that this industry produced something more than 500 million and as much as 2 billion individual castings during 1948. No other segment of the foundry industry is currently geared to this level of know-how on high production of small parts. Should the malleable foundry industry be confronted with a temporary headache, I would suggest that it may stem from the



Effect of gradually increasing proportions of spheroidal graphite on fracture appearances of cast iron.

Left—Gray cast iron, flake graphite. Right— Ductile cast iron, spheroidal graphite.

Of course, competition of materials and industries became keener but the size of the industrial pie grew at a faster pace.

As ductile iron is well adapted to foundry processing techniques, one might forecast that the lion's share of a growing industrial pie would move toward the foundry rather than its competitive industries. I think I would be quite conservative in estimating a possible 20 million product ton performance for the foundry industry at some future time when the business conditions of 1948 are approximated or exceeded.

What does the impact of this technological development pose for the malleable foundry industry? In a sense the real answer to this question resides with the malleable foundry industry. I would say that the impact right now poses a bit of a headache for the industry, but the long view is definitely beneficial. The malleable foundry industry can, and is, utilizing this technological advancement.

For almost 125 years the basic plan for producing blackheart malleable iron has persisted without radical departure from it. This does not mean that there has not been continuous progress in the melting, foundry, production and annealing techniques for malleable iron foundries, nor that radical departures without full development of the basic plan are always progressive.

integrated companies operating captive foundies and mainly in the automotive, agricultural equipment and electrical industries.

Earlier in this discussion it was stated that with certain qualifications the hardness of ductile iron, malleable iron and cast iron would be about equal with equivalent chemistry and heat treatment conditions.

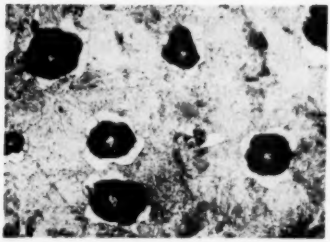
Some foundries have made both nodular iron by annealing white iron and spheroidal carbon iron by the magnesium-treated process. These companies know that the attainable engineering properties of ductile cast iron are greater than those attainable in nodular carbon iron. There are several fundamental reasons for this: first, there is a great difference between spheroidal graphite and nodular graphite; second, a broad utilization of silicon as an alloying element becomes operative; and third, manganese becomes an important alloying element in a low-sulphur iron.

Boegehold assessed the ultimate strength of pure ferrite at about 36,000 psi, and the value of silicon in silico-ferrite at 12,000 psi per 1 per cent silicon. Approximate ultimate strengths of 1, 2 and 3 per cent silicon containing silico-ferrite would be 48,000, 60,000, and 72,000 psi, respectively.

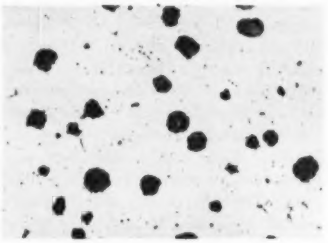
Most of the ductile irons we have made to date had yield strengths in excess of 60,000 psi. Many foundry-

Flake Graphite Iron
Etched *Unetched*

Photomicrographs of same base iron showing transformation of graphite from flake to spheroidal form.



Spheroidal Graphite Iron
Etched *Unetched*



men will recall the real problems of meeting army ordnance requirements of 42,000 psi minimum yield on malleable iron a few years ago. Where these requirements were met, they were met by alloying or special heat treatments. Had the malleable industry had the magnesium-treated process available then it would have met yield strength requirements quite readily.

If we ask the question, "Can blackheart malleable be produced by the magnesium-treated process?" the practical answer could be "yes and no." If by blackheart malleable we simply mean a black-fracture material, the practical answer would be "no" because nodular graphite and spheroidal graphite are quite unlike. The fracture of spheroidal graphite iron is metallic. However, if by blackheart malleable is meant a material that can be produced to superior levels of yield strength, elongation and machinability, the practical answer is "yes."

Any technological development must match definite economic limitations if it is to achieve practical use. How much does it cost to produce magnesium-treated cast iron? Any remarks I make on this subject are confined to the direct costs of the producer and do not consider his overhead, selling expense and profits and, consequently, are not translatable to the consumer without due consideration to these factors. As ductile irons may be produced from smelting as well as melting operations, the cost per unit of hot metal will vary with the particular base line we may have in mind.

Costs per unit of hot metal vary with such factors as tonnage produced, type of melting furnace, geographic location, cost of available raw materials, including fuel and type of metal produced. For example, the cost per unit of hot metal in a cupola operation melting 1000 tons per day and located in an area of broad availability of raw materials could be greatly different than the cost per unit of hot metal in a foundry melting one ton of a special grade of malleable iron. Limiting our immediate consideration to melting operations and to the primary objective of producing spheroidal graphite instead of flake or primary graphite and not making adjustments for using lower cost raw materials or achieving additional objectives other than spheroidal graphite, techniques are now in use that amount to $5 per ton of hot metal.

It is not inconceivable that full utilization of these techniques would result in over-all costs equal to or less than present costs. Of course, achieving additional objectives would increase the costs above the figure mentioned. Probably the broad scope of cost consideration ranges up to $20 per ton of hot metal, but in the final analysis how do we compare costs on a cast iron of 20,000 psi with one of 200,000 psi, or a cast iron with no ductility with one having 25 per cent elongation, or with a malleable iron of 35,000 psi yield strength and a ductile iron of 70,000 psi yield strength?

Acknowledgments

I should like to pay tribute to my associates, A. P. Gagnebin and Keith Mills for their brilliance in research and for their patience and perseverance. They researched in a field of metallurgy whose tantalizing secrets have challenged many researchers for a long time and came up with the answers. I am grateful to my company for the funds, research facilities and skills it has made available for research work on foundry processes and products.

C. K. Donoho, Metallurgist
American Cast Iron Pipe Co., Birmingham, Ala.

In the February, 1949, issue of AMERICAN FOUNDRYMAN (pp. 30-37) we had an article entitled "Producing Nodular Graphite with Magnesium." We would like to take this opportunity to elaborate on some of the points discussed in that paper, and to modify some of the tentative conclusions.

For one thing, we indicated that the use of a graphite inoculant after the magnesium addition would

cause a reversion to flake graphite, which it did in several instances. However, we have since found that this is not always the case. For example, an experimental heat of induction melted iron of percentage composition: T.C., 3.70; Si, 2.90; S, 0.04; P, 0.03; Mn, 0.03, was covered in the ladle with a 1-in. layer of granular graphite and a pure magnesium rod inserted into the metal through the graphite layer. The 0.85 per cent magnesium addition gave 0.056 per cent magnesium in the metal for a 7 per cent recovery. Ferrosilicon was added and both the FeSi and the graphite stirred into the metal.

Cast in a keel block with 1-in. section coupons this metal had 179 Bhn and was completely nodular, with at least 90 per cent ferrite in the matrix (Fig. A). The as-cast ductility was the best that we have obtained. The as-cast and annealed properties were:

Tensile Strength, 1000 psi	Yield Point, 1000 psi	Elongation, % in 2 in.	Red. of area, %	Bhn	Mod. of Elasticity 10^6 psi.
75.6	51.1	18.6	15.1	179	23
(annealed at 1350 F for 1 hr and air-cooled)					
71.5	50.0	23.4	26.1	163	22

With the low hardness and good ductility obtained in the as-cast condition, we would not need to anneal this iron ordinarily.

The foregoing properties show that graphite-base inoculants are not always fatal to the process, and if we tended to infer this in our publication we apologize to the proponents of these inoculants.

Also in the paper referred to we showed a test on the effect of holding time which was somewhat alarming. We remarked the need for more data on cupola irons. The questions of shrinkage and fluidity in these treated irons were more or less glossed over. We believe that these points can be clarified to a large degree by describing one of our latest production casts.

The base iron was cupola melted and was of the following percentage composition before treatment: T.C, 3.80; Si, 2.12; S, 0.091; Mn, 0.37; P, 0.07.

The cupola was tapped into 1000-lb ladles. When each ladle was about 1/3 full a 13-lb addition of 70 per cent copper-magnesium alloy was made. We realize that this is not the best all-purpose magnesium alloy, but it is the one with which we had the most experience at that time. The ladle was allowed to fill to the 1000-lb mark and conveyed to the casting floor. Just before casting 0.50 per cent silicon was stirred in and the ladle skimmed. The composition after treatment was 2.79 per cent Si, 0.022 per cent sulphur, and about 0.04 per cent Mg. One-in. diameter test bars and spectrographic samples were cast from the *first* and the *last* iron from each ladle. Pouring of each ladle required from 11 to 12 min, but in no case was there any significant change from first to last iron in any ladle.

Tensile strengths for three consecutive ladles were as follows:

		Tensile Strength 1000 psi
Ladle No. 1	first iron	99.1
	last iron	94.1
Ladle No. 2	first iron	94.2
	last iron	94.0
Ladle No. 3	first iron	106.8
	last iron	109.3

(Bhn as-cast about 255-262)

Having obtained high strength nodular iron from the first iron and the last iron from each ladle, we are assured that the castings poured in between are also completely nodular. Keel block tests from ladle 2 showed only 3 per cent elongation as-cast with 95,000 psi tensile strength but:

Tensile Strength, 1000 psi	Yield Point, 1000 psi	Elongation, % in 2 in.	Red. of area, %	Bhn
70	50	22	22	170

after anneal at 1650 F for 1 hr, cool to 1350 F, hold for 1 hr, and air cool.

Several plate castings were entirely unfed by risers but with this high carbon iron showed no detectable

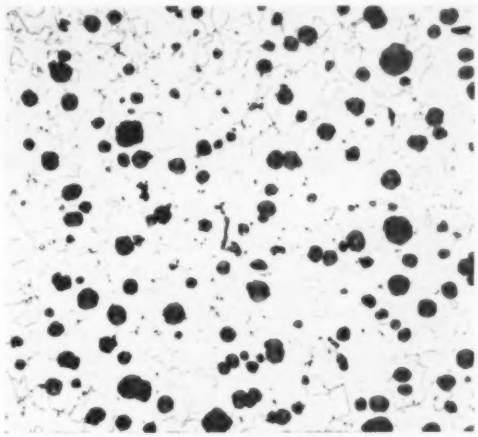


Fig. A—Structure of nodular graphite iron with as-cast matrix almost completely ferritic. Nital etch. X100.

shrinkage. The fluidity was surprisingly good; with about 2450 F average pouring temperature even 1/8-in. diameter vent holes were run to form "knitting needles" 8 in. long.

This cast answered several questions for us: (1) that we could treat cupola metal from ladle to ladle to give consistent properties (this was by no means the only time); (2) that we could hold the metal as long as 15 min without loss of the effect; (3) that with high-carbon base iron, neither shrinkage nor fluidity was a serious problem.

Gosta Vennerholm, Metallurgist
Ford Motor Co., Dearborn, Mich.

The progress made during the past few years toward the realization of the foundrymen's dream, as-cast malleable iron, is indeed encouraging.

The presence of primary graphite nodules in cast irons has been observed frequently over the years, particularly in conjunction with highly under-cooled structures exhibiting inverse chill, and at times has been referred to in the literature. It is of interest to note, for instance, that as far back as 1914 Johnson reported in the *Bulletin* of American Institute of Mining Engineers that by melting ordinary pig iron

with spongy highly oxidized iron a pronounced improvement in strength was obtained, which he attributed to "the presence of oxide of iron causing the graphite to separate in nodular form instead of in plate or flakes as is common in the weaker irons."

Not until the findings of the British Cast Iron Research Association were made available, however, in early 1947 and more fully in February 1948, did we suddenly realize that a method had finally been found by which the production of nodular graphite in the as-cast state in cast iron could be controlled at will.

Many Research Projects Started

The interest aroused was intense, and it is only natural that in many laboratories throughout the foundry industry various research projects were begun to learn more about this development. Relatively little of the findings resulting from this work has appeared in the literature to date, but the topic of nodular iron seems to be uppermost in everybody's mind. It is only natural that the lack of factual data as to the potential possibilities of these irons has, in many instances, led to misunderstanding and faulty conclusions, which if not corrected at an early date may hinder progress.

Although we at Ford's are not yet using nodular iron, an intensive research program has been under way for a considerable length of time in which over 100 heats involving nearly 1000 variations have been made while investigating 35 different alloy additives. All the answers are not yet at hand, but I believe that the time has come when we may well stop for a moment and take stock of our findings.

The frequently expressed thinking that cerium, magnesium, or similar treatments present a clear-cut method which is applicable to any type of cast iron and will result in high strength and high ductility requires some clarification.

When conventional cupola iron with a phosphorus content of around 0.15 to perhaps 0.30 per cent and the manganese in the normal range of from 0.50 to 0.90 per cent is treated with magnesium to produce nodular graphite, a great increase in the strength results. However, such a material can hardly be called ductile as under those conditions the ductility does not exceed 1.5 per cent.

A study of the factors affecting the ductility has shown that both phosphorus, and to a lesser extent manganese, seriously influence the same. It therefore becomes evident that if ductile irons in the as-cast condition (and we are now speaking of from 6 to 9 per cent) are to be produced, this will require special raw materials low in phosphorus and manganese.

Critical Analysis Needed

Aside from the foregoing considerations, a very low sulphur content is a prerequisite for the formation of nodular graphite. As this is not inherent in conventional cupola irons, special means must be used. From this, one can only conclude that before we dash headlong into the manufacture of nodular cast iron, a critical analysis of engineering properties, manufacturing methods, and the economic factors must be made.

Although the engineering properties of nodular irons are not as yet fully evaluated, such irons give promise of being specialty materials with unique characteristics which are bound to find numerous applications; indications are that these irons will supplement rather than replace the present alloys.

The physical properties developed in these irons are dependent upon the type of structures produced. Conventional cupola irons with a normal phosphorus and manganese content, when magnesium treated, will show a fully pearlitic matrix with nodules interspersed. Tensile properties of from 80,000 to 105,000 psi are readily obtained in this manner, although the ductility, as already mentioned, is rarely over 1½ per cent. However, a number of applications are at hand for irons exhibiting such properties and more, no doubt, will be found (Fig. 1).

Manufacture of these irons does not present any serious problem, but the relatively large amount of sulphur (0.10 to 0.12 per cent) does require excessive amounts of magnesium additions which greatly add to the cost as well as the hazards involved, unless the sulphur is partially removed beforehand by soda-ash treatment. This process is somewhat erratic, making the calculation of the exact amount of nodulizing agent required difficult. Experience to date has indicated that the ductility is adversely affected by unnecessarily large magnesium additions.

Blast Furnace Iron Used

It is of interest to note that we have been able to circumvent high sulphur content by using direct blast furnace iron of the following analysis: C, 3.80-4.10 per cent; Mn, 1.00-1.25 per cent; Si, 1.25-1.50 per cent; P, 0.22 per cent; S, 0.04 per cent. The physical properties obtained in this manner equal those of the cupola iron discussed earlier (Figs. 2 and 3).

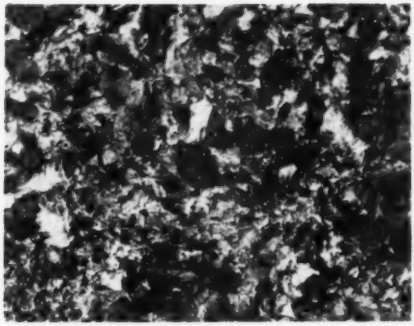
Where the engineering requirements call for higher ductility than that obtainable with conventional cupola iron analysis, it becomes necessary to use specially selected raw materials in order to achieve the desired low phosphorus and low manganese contents. Such irons exhibit somewhat lower tensile properties, but show an appreciable increase in ductility.

The various limitations present in the processes described can be greatly minimized by utilizing electric or similar melting units, in which the pertinent elements can be controlled to much closer limits (Fig. 4). As a result, greatly improved physical properties have been obtained in this manner and we can say here that we are dealing with truly ductile materials comparable in the as-cast condition with pearlitic malleable, and after short-time heat treatment with ferritic malleable.

A typical such iron of the following analysis: C, 3.72; Mn, 0.33; Si, 1.98; P, 0.02; S, 0.019 per cent, treated with 0.35 per cent magnesium in a 50:50 magnesium-copper alloy exhibited physical properties as indicated in the as-cast condition:

Tensile Strength, psi	80,000
Yield Point, psi	60,000
Elongation in 2 in., per cent	8
Brinell Hardness	192

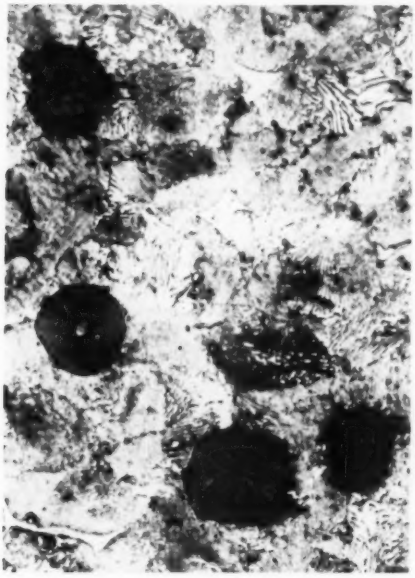
It is of great interest to note that these irons are very susceptible to low-temperature short-cycle heat treat-



X100

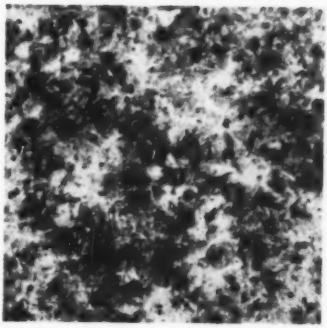
X500

Fig. 1 (above and right)—Microstructures of blast furnace iron which was treated with 50:50 Mg-Cu alloy. Nital etch.



X500

Fig. 2 — Microstructures of cupola iron which was treated with 50:50 Mg-Cu alloy. Nital etch.



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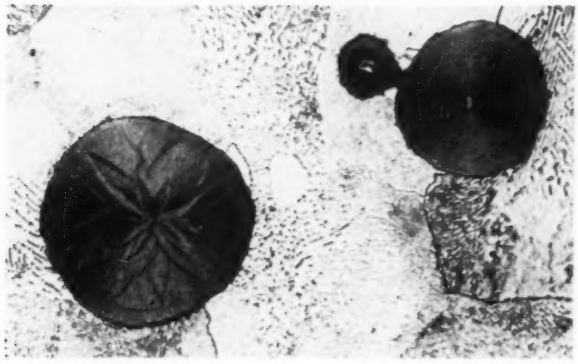
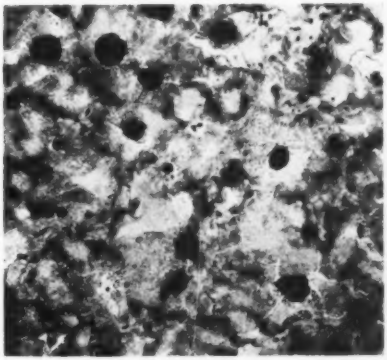




X100

Fig. 3—Microstructures of blast furnace pig iron remelted in electric furnace and treated with 50:50 Mg-Cu alloy. Nital etch.

X500

ment. The above-mentioned iron, after a heat treatment of 2 hr at 1320 F, had the following properties (Fig. 5):

Tensile Strength, psi	60,000
Yield Point, psi	42,500
Elongation in 2 in., per cent	16
Brinell Hardness	138

When heated for 5 hr at 1750 F and cooled to 1320 F at the rate of 200 F, and held at 1320 F for 2 hr, the properties were as follows:

Tensile Strength, psi	56,000
Yield Point, psi	40,000
Elongation in 2 in., per cent	18
Brinell Hardness	131

This indicates that little, if anything, was gained by the lengthy heat treatment.

If we now view the economic aspects of these various manufacturing methods, we may summarize our cost data as follows:

	% S	% Mg (50/50 Cu Mg) Required	Mg[1] Cost Ton	Cost[2] Conversion/Ton	Total Alloy & Conversion
Cupola Iron Molten Basic	0.12	0.7	11.20	5.40	16.60
Blast Furnace	0.04	0.5	8.00	2.20	10.20
Cold Melt Electric (low sulphur)	0.03	0.3	4.80	10.60	15.40

[1]Cost of magnesium alloy assumed 40c per pound.
[2]A. W. Gregg, "Iron Melting Costs in Cupola and Electric Furnace," *The Foundry*, Feb. 1949.

From this analysis it will be noted that the electric furnance may compete economically with the cupola as a source of metal for magnesium treatment. This is of considerable interest in particular as the added advantage of complete control of the raw materials will be reflected in improved physical properties.

Although it is too early to speculate as to the ultimate place of spherulitic iron in the casting industry, it would seem from the following analysis that for the moment spherulitic iron does not present any economic advantage over malleable irons except that it broadens the field of application because of its lower sensitivity to increased section thickness. (I said, "*for the moment*," because the extensive research under

Method of Manufacture	Cost: Conversion	Alloy	Heat Treat	Total	Advantage
PEARLITIC MALLEABLE					
Conventional Cupola-Air Furnace	7.60	—	9.00	16.60	
Spherulitic-Cupola	5.40	11.20	—	16.60	Allows the use of material in heavier sections
Spherulitic-Electric Furnace	10.60	4.80	—	15.40	
FERRITIC MALLEABLE					
Conventional Cupola-Air Furnace	7.60	—	9.00	16.60	
Spherulitic-Cupola	5.40	11.20	6.20	22.40	Allows the use of material in heavier sections: slightly higher Y.P. and T.S.
Spherulitic-Electric Furnace	10.60	4.80	6.00	21.40	

Fig. 4—Low phosphorus, low sulphur and low manganese iron which was melted in electric furnace and treated with 50:50 Mg-Cu alloy. Nital etch.

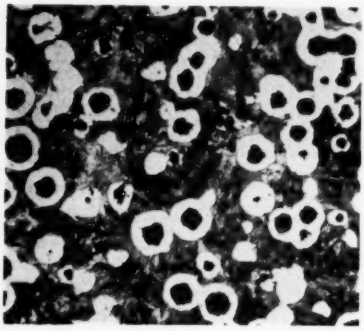
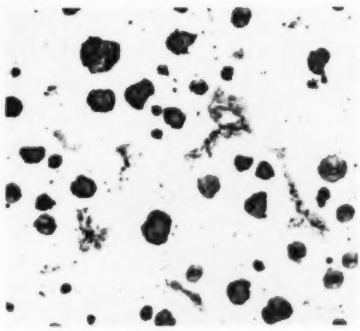


Fig. 5 (right)—Microstructure of the same iron shown in Fig. 4 after 2-hr heat treatment at 1320 F. Nital etch.



GRAY IRON

	Reg.	Alloy (1% Ni) (0.5% Mo) (0.5% Cr)	Acicular (2% Ni) (0.75% Mo)	Spherulitic
Method of Manufacture	Cupola	Cupola	Cupola	Cupola
Conversion Cost	5.40	5.40	5.40	5.40
Alloy Cost	—	15.00	23.00	11.20
Total Cost	5.40	20.40	28.40	16.60
Tensile Strength, 1000 psi	45	60	80	80-105
Elongation in 2-in., %	< 1	< 1	< 1	1-3
Brinnel Hardness	229	269	302	255
Modulus of Elasticity, psi $\times 10^6$	17	18	19.5	23-24

way on nodulizing agents may at any time necessitate a complete revision of our thinking.)

In the gray iron field, on the other hand, no such direct cost comparison is possible due to the differences in inherent properties of the two materials, which therefore necessitates a critical analysis of each application. It is, however, of interest to note that spherulitic iron may advantageously replace alloy irons provided that damping characteristics and similar properties are not critical.

As I said at the outset, the picture is still confused; but as we learn more about this interesting material, we will no doubt find numerous applications for spherulitic graphite iron where its unique characteristics can be utilized. However, I again want to stress that I believe that these spherulitic graphite irons will augment rather than replace the present ferrous casting alloys.

R. G. McElwee
Manager, Iron Foundry Division
Vanadium Corp. of America, Detroit

Much interesting and instructive information on nodular graphite cast iron has been presented today and in various publications recently. While it is not intended to discredit anything published or presented, it seems well to define a few limitations of the material and the methods of making it.

It is reported that foundrymen and metallurgists are working feverishly to develop more information on nodular graphite irons. Our organization is doing this and eventually we hope to be able to contribute to the over-all store of information. The more investigators operating in the field, the more ideas will be tried and the faster we all will progress.

We are asked everyday how to make nodular graphite cast iron. Our advice in cases where the shops have no control whatsoever is to "get your house in order first." We cannot be so optimistic as to conclude that *any* foundry can make satisfactory castings of iron with nodular graphite in the as-cast condition.

Nodular iron can be made at practically any sulphur level, but it is important to know what that level is. We would hesitate to recommend an addition of a magnesium alloy to an iron containing 0.20 per cent sulphur while assuming that it contained only 0.10 per cent. It is just as serious to add too little magnesium as it is to add too much. Some control is essential.

We have done some experimental work with an electric furnance, and from Mr. Vennerholm's remarks it appears that this melting unit may become more widely used, particularly in connection with nodular graphite iron production.

At present, too little is known about the behavior of this new material in service. Many laboratory and service tests must be performed before the new development can be fully evaluated. Elongation, which has received the greatest attention, is not alone sufficient cause for the selection of a material for most engineering applications.

We must recognize that we are on the threshold of one of the most important metallurgical developments of the age. When the technique of manufacture becomes universally known many worthwhile applications of nodular graphite cast iron can be expected.

Future Meetings and Exhibits

INSTRUMENT SOCIETY OF AMERICA, 4th national instrument exhibit, St. Louis Municipal Auditorium, St. Louis—Sept. 12-16.

MAGNESIUM ASSOCIATION, quarterly meeting, Hotel Statler, Detroit—Sept. 15-16.

NATIONAL ASSOCIATION OF FOREMEN, 26th annual convention, Statler Hotel and Masonic Temple, Detroit—Sept. 21-24.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, midyear meeting, Columbus, Ohio—Sept. 25-Oct. 1.

AMERICAN MINING CONGRESS, Spokane, Wash.—Sept. 26-28.

AMERICAN IRON & STEEL INSTITUTE, regional technical meeting, Hotel Statler, Buffalo, N. Y.—Sept. 29.

MAGNESIUM ASSOCIATION, midyear meeting, Greenbrier Hotel, White Sulphur Springs, W. Va.—Sept. 29-Oct. 1.

NEW ENGLAND REGIONAL FOUNDRY CONFERENCE, Massachusetts Institute of Technology, Cambridge, Mass., Oct. 7-8.

AMERICAN SOCIETY FOR TESTING MATERIALS, Pacific Coast Meeting, Fairmount Hotel, San Francisco—Oct. 10-14.

STEEL FOUNDERS' SOCIETY OF AMERICA, fall meeting, Ambassador Hotel, Los Angeles—Oct. 13-14.

FOUNDRY EQUIPMENT MANUFACTURERS ASSOCIATION, annual meeting, The Greenbrier, White Sulphur Springs, West Virginia—Oct. 13-15.

AMERICAN SOCIETY FOR METALS, metal congress and exposition, Public Auditorium, Cleveland—Oct. 17-21.

REGIONAL FOUNDRY CONFERENCE, Metropolitan, Philadelphia and Chesapeake Chapters of A.F.S., Stevens Institute of Technology, Hoboken, N. J., Oct. 21-22.

NATIONAL SAFETY COUNCIL, 37th National Safety Congress and Exposition, Chicago, Oct. 24-28.

GRAY IRON FOUNDERS' SOCIETY, annual meeting, Edgewater Beach Hotel, Chicago—Oct. 27-28.

MICHIGAN REGIONAL FOUNDRY CONFERENCE, A.F.S. Michigan Chapters, Michigan State College, East Lansing—Oct. 28-29.

NATIONAL FOUNDRY ASSOCIATION, annual meeting, Waldorf-Astoria Hotel, New York—Nov. 10-11.

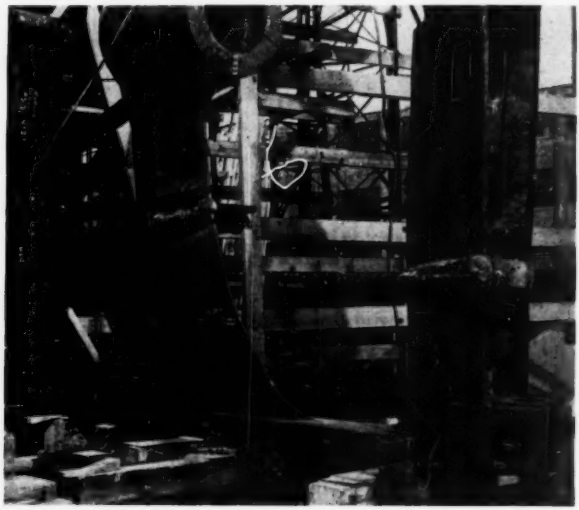
NEW YORK STATE REGIONAL FOUNDRY CONFERENCE, A.F.S. Upstate New York Chapters, Syracuse University, Syracuse, N. Y.—Nov. 25-26.

PLANT MAINTENANCE SHOW & CONFERENCE, Cleveland—Jan. 16-19, 1950.

54th Annual Foundry Congress and Exhibit, American Foundrymen's Society, Public Auditorium, Cleveland. May 8-12, 1950.

MODERN FOUNDRY METHODS

▲ *A ship's stern frame casting made up of four sections thermit welded together.*

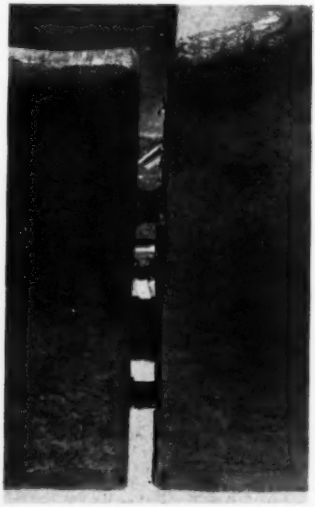


The four-section thermit welded stern frame casting is placed in position on a ship. ▶

This month's Modern Foundry Methods, illustrating the thermit-welding process of producing large steel castings for ships' structures, was taken from the paper "Steel Castings in Welded Assemblies," by John Howe Hall, Consultant, Swarthmore, Pa., presented as the Charles Edgar Hoyt Annual lecture at the 53rd Annual Meeting of A.F.S. at St. Louis, May 4, 1949. The complete lecture will appear in A.F.S. TRANSACTIONS, *vol. 57, 1949.*

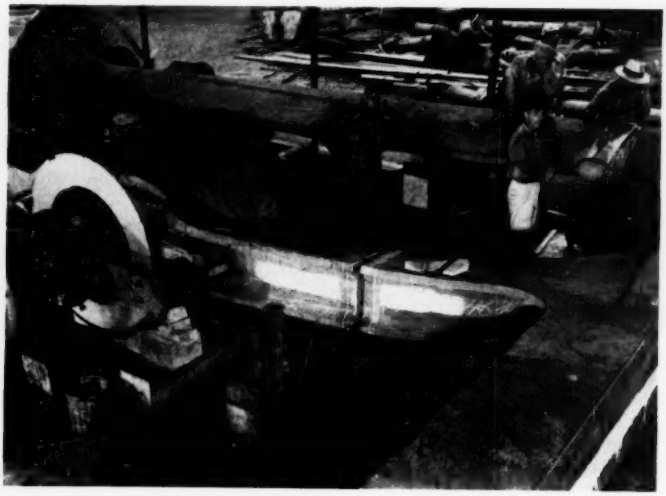
The number of steel foundries that are equipped to produce large ships' castings, such as the heavy stern frames shown, is rather limited. In addition, railroad transportation difficulties have made it necessary in the past to produce the largest castings in foundries located close to deep water. At times when large quantities of heavy ships' castings are needed quickly, these conditions result in serious delays in ship construction.

Casting the frames in sections and assembling them by thermit-welding at the shipyards or in shops located near tidewater makes it possible for



▲ *Casting sections are tack-welded across the joints to maintain space.*

◀ *Sections of the stern frame casting are set up for thermit welding. A wax pattern for one joint is shown nearing completion.*



...MODERN FOUNDRY METHODS

After completion of a joint mold torches ➡ are applied for mold drying and heating.

⬇ A sand mold is rammed up around the wax pattern.

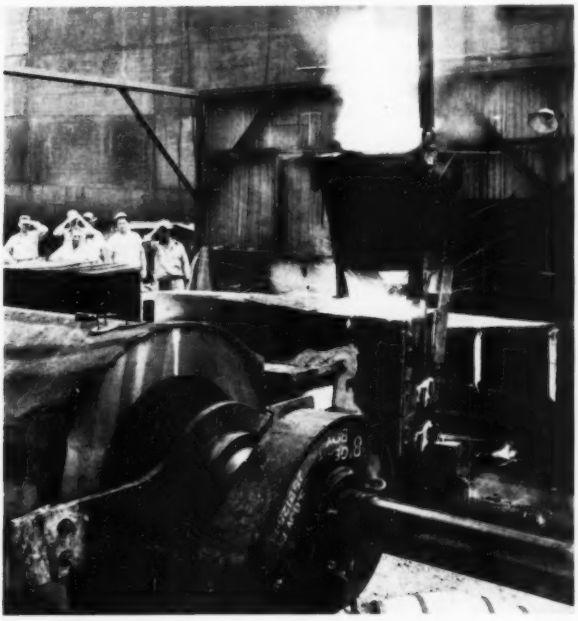
the sections to be produced in foundries which are not equipped to make the castings as integral jobs.

The accompanying photographs show the various steps in welding together a ship's stern frame made up of four separate castings. The first step in the process consists of setting up the frame and tack-welding across the joints in order to maintain proper spacing. A wax pattern is shaped around each joint, and the sand mold rammed up around the pattern. Drying out and heating the mold is accomplished by the use of torches.

Steel of any desired analysis can be obtained in the weld deposit by compounding the thermit powder.

Temperatures of the thermit-produced metal are so high that a zone of metal around the weld is sufficiently overheated to give it a coarse microstructure. If uniformity of weld metal and base metal is considered essential, complete heat treatment of the welded structure is necessary. Otherwise, a simple stress-relieving treatment will suffice.

Acknowledgment is made to the Bethlehem Steel Co. and to the Metal & Thermit Corp. for their courtesy in supplying the photographs.



⬆ Pouring gate and risers are shown in position on this thermit-welded stern frame casting.

⬅ Pouring the thermit weld on one section of a stern frame casting.

RESEARCH WILL ADVANCE BRASS AND BRONZE FOUNDRY PRACTICE

Austen J. Smith
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Michigan State College
East Lansing, Mich.

MUCH ATTENTION has recently been centered on the possibility of achieving sound castings of the brass and bronze alloys through application of sound scientific principles to the melting and gating procedures. Many of the problems became evident during the war when virtually all foundry products were manufactured to government specifications, with which many foundries had had no previous experience. As a consequence, research in the bronze foundry was actively advanced.

Many recent papers published in England have shown that the problems have been the same on both sides of the ocean. The British publications have been most eagerly awaited in the United States and the names of a number of the British workers are almost as familiar to the members of the American Foundrymen's Society as they are to the members of the Institute of British Foundrymen.

Rather than to present, as an Exchange Paper, a report on original research on bronze foundry practice, it seems more desirable to review some of the problems for which foundrymen do not yet have an answer, and to touch on some of the work now in progress in the United States.

Although Finch, in a most stimulating paper[1] before this Institute two years ago, described the process of the freezing of castings, a somewhat different point of view makes it desirable to reconsider the whole casting process and to discuss some of the factors affecting the final product.

To get some idea of certain factors that affect the freezing process, it will be well to describe a simple experiment. The ideas brought forth are not entirely new. Something of the same substance was presented by Finch[1] and Frear[2].

Freezing Process Mechanism

A series of cylindrical blocks 4½ in. long and nominally 2-in. diameter, both with a generous taper, were molded in green sand with the larger end up and open to the air. Castings were poured at different temperatures down to a temperature near that of initial solidification. Pouring was rapid, so that the temperature in the mold at the end of pouring was little below the actual pouring temperature.

The alloy used was "steam" bronze of the nominal composition 6 per cent Sn, 3.5 per cent Zn, 1.5 per cent Pb, balance Cu. The resulting castings were split down the center and etched. In Figs. 1 to 5 the etched sections are shown sketched schematically, salient features being brought out more readily by sketching than by photography.

Pouring temperatures from 2400 F (1315 C) down to 2000 F (1093 C) at 100 F intervals are shown. With a pouring temperature of 1950 F (1065 C) a grain size of some 1/16-in. diameter was obtained, and at 1900 F the grain was too fine even to estimate by visual inspection. Initial solidification in this alloy occurs at about 1870 F (1021 C). The block poured at 1900 F (1037 C) showed a general over-all shrinkage and the top was filled with blow holes, indicating that freezing took place too rapidly to permit the escape of gases entrapped in the metal.

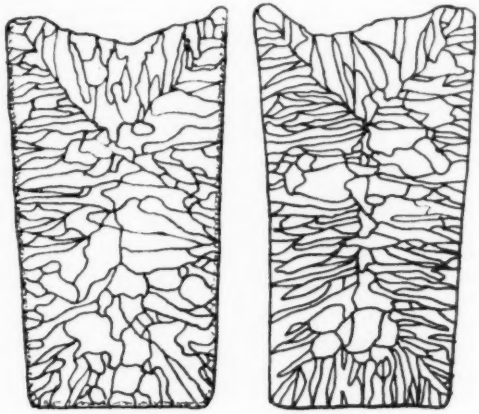
Freezing commences at points in the liquid, that is, at nuclei, which may be particles of foreign matter or may be associations of two or more atoms brought about through temperature change alone. As freezing progresses, growth from the nuclei will proceed in the direction away from which heat is being abstracted, but still along definite crystallographic axes.

There is a limiting angle, as yet not determined, which the preferred axial direction may make with the cooling direction and beyond which growth will not occur. This limiting angle is, of course, modified by adjacent freezing crystals. Were there to be but a very slight temperature gradient the crystals would tend to grow in all directions from the nuclei as cooling progresses, the final shape of the grains being determined by interference from adjacent growing crystals.

As the temperature gradient becomes greater the growth becomes more unidirectional. Superimposed on this effect is the temperature over which both solid and liquid can coexist—the freezing range. A narrow freezing range accentuates the effect of temperature gradient, a long "mushy" range rather obliterates it.

When molten metal is poured into a mold the metal in contact with the surface of the mold will form nuclei at a very high rate, for the metal will be quickly

Fig. 1—2400 F (1315 C). *Fig. 2—2300 F (1260 C).*



cooled below its freezing point. Many of these centers of crystallization will be unfavorably oriented for growth to proceed; others will be in a more favorable position and growth will proceed until interfered with by the growth from those centers which are highly favorable in their orientation.

Hence, at the surface of a casting there is a thin layer of fine grained material with almost complete random orientation. This as-cast surface rarely leaks unless unsoundness is very great. Leakage often becomes apparent only after this layer has been machined away. The layer has been sketched in Fig. 1 (much grosser than it actually exists), but it is present in all castings with the exception of those whose mass is so great with respect to the cooling velocity that the surface layer is remelted.

Pouring Temperature Effect

If the metal be poured hot, the metal remaining at the center after this initial surface crystallization will still be too far above the melting point to form new crystallization centers. As a consequence, freezing metal will build up on the surface crystals which are favorably oriented for growth, and the product will be a dendritic structure, the dendrites in many instances growing toward the center until stopped only by dendrites growing from the opposite surface. This is illustrated in Fig. 1.

If feeding cannot wholly replace the solidification contraction with this freezing pattern, centerline shrinkage results. Since centerline shrinkage is not often of serious consequence in the copper-base alloys it will not be considered further here.

As the pouring temperature is lowered the metal at the center drops into the nucleation temperature range so that new points of crystallization are formed at the center even while dendrites are growing inward from the surface. As the dendrites approach the center they will be checked from further growth by these new grains, which will be more or less equiaxed. This condition appears first in Fig. 2, and is quite pronounced in Fig. 4, sketched from a casting poured at 2100 F.

Finally, at 2000 F (1093 C) nucleation at the center

A review of bronze foundry problems and the work being done toward their solution is the theme of the annual Exchange Paper from the American Foundrymen's Association to the Institute of British Foundrymen. Twenty-eight in the sequence—1922-1949, the paper was presented at the 46th Annual Meeting of the Institute of British Foundrymen, at Cheltenham Spa, England, June 14-17, 1949.

is far too rapid for dendritic growth to take place, and the entire block takes on an equiaxed structure except for a few small dendrites. With still more rapid nucleation resulting from yet lower pouring temperatures, the size of the equiaxed grains becomes reduced and there is a complete disappearance of any significant dendritic growth.

Nucleation at the center can be pronounced only in alloys with a freezing range since such alloys may form nuclei over a range of temperatures permitting freezing to take place at a number of centers at once. In a pure metal such as pure copper, the invariable freezing habit is dendritic down to the point where the metal can no longer be poured, for, with no freezing range, any temperature gradient is significant, and the gradient can only be from the surface inward.

As indicated in this first experiment, for alloys with a mushy range a fairly steep temperature gradient is required for dendritic growth, i.e., a marked difference in temperature from the surface of the casting to the center. If the difference be less than a certain amount, equiaxed grains may grow in the center. The mold surface produces a marked chilling effect on the first metal coming in contact with it.

Application to Feeding

If the mold is heated greatly, as by a large mass of metal taking a considerable time to freeze, the effect of a steep temperature gradient is lost regardless of the pouring temperature. Thus, in alloys with a mushy range, there would appear to be a limiting sectional size beyond which it would not be possible to have a wholly dendritic structure regardless of pouring temperature. Also, with thinner sections there would

Fig. 3—2200 F (1204 C).

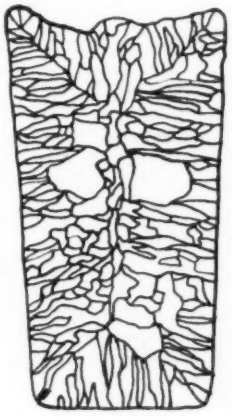


Fig. 4—2100 F (1148 C).

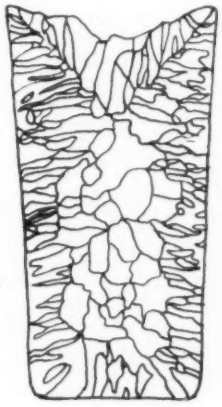
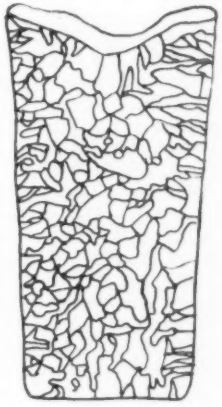


Fig. 5—2000 F (1093 C).



Figs. 1-5—Sketches showing the crystal structure of bronze blocks cast at temperatures from 2400 to 2000 F (1315 to 1093 C) at 100 F (55 C) intervals. In the original work intervals of 50 F were employed, but the pattern is well represented at the 100 F intervals sketched here.

be a lower limit below which equiaxed grains would be unable to form, no matter how low the pouring temperature.

The mode of structural growth is very important in the feeding of castings. The gradients required to produce the two different types are susceptible of measurement and, while they will be different for different alloys, they should offer excellent correlative possibilities. Factors affecting the operation of temperature gradients over and above the temperatures of metal and mold at pouring include, among others, rate of heat transference between metal and mold, heat conductivities, and specific heats.

Many attempts have been made to study gating practices from the theory of heat transference alone. A recent endeavor in this direction was that of Faber and Doll[3]. However, such evaluation is only a part of the problem, although an important part. Work is also being carried on in making direct measurements of heat transference from metal to mold, as well as studies that are being carried on by the electrical analogy method.

The work now being carried on at Columbia University under the sponsorship of the American Foundrymen's Society Heat Transfer Committee is expected to make an important contribution to this subject. Their reports have appeared regularly in the TRANSACTIONS of the Society[4]. The use of the ratio of volume to surface area by many foundrymen is a somewhat less rigorous attempt in the same direction.

Contraction Characteristics

With few exceptions metals continuously contract when the temperature falls from the pouring temperature to room temperature. The contraction is not uniform, but is different for each phase. Further, a separate discontinuous contraction is shown for each phase change with falling temperature. Thus, with the normal solid-solution alloy cooling from the molten state there is shown liquid contraction, solidification contraction, and solid contraction.

Some reasonably good measurements have been made of liquid contraction; for the brass and bronze alloys the work of Sager and Ash[5] at the National Bureau of Standards a number of years ago still appears to be quite reliable. Solid contraction is simply a restatement of the familiar thermal coefficient of expansion.

Solidification contraction is much less easily defined. If the alloy freezes over a range of temperatures, then all three varieties of contraction will be taking place simultaneously, for liquid and solid will both be present and also liquid in the process of transforming to solid.

Measurements of this grouped "solidification" contraction have been made for a number of alloys, for the copper-base alloys also by Sager and Ash[5]. Little recent work has appeared on such measurements for these alloys. The measurements that have been made are restricted to the conditions of the experiment, since cooling rates govern the composition of phases as they pass through a transformation range and hence affect also the contraction characteristics.

This is particularly true in freezing processes because of segregation effects, which at times may be extreme. However, the measurements are useful as a first approximation. In the study of risering practice it is not possible to measure the behavior under conditions of true equilibrium, since such conditions are virtually impossible of attainment. With sufficient data taken under controlled experiment it should be possible to extrapolate to conditions of equilibrium which would make the ideal reference point. In the author's knowledge, no work of this type has been attempted.

Little is known of the dependence of the observed contraction characteristics on cooling rates. An evaluation would call for knowledge of the segregation behavior and of the phase equilibria of the alloys in question. With the gathering of this knowledge there again should be excellent possibilities for correlation.

Feeding Castings

At this point it will be of interest to consider the problems involved in the production of a sound casting. The blocks described earlier may be thought of as analogous to risers on regularly gated castings. In order to fulfill the purpose when used as a feeding head, the riser must remain molten as long as the casting is above the temperature of final solidification. As the casting solidifies contraction takes place and the resulting voids must be filled with molten metal from the riser. Obviously, feeding cannot take place if the riser, or the gate between riser and casting, is not sufficiently molten to permit flow.

Without inquiring further into the mechanics of flow, a difference of temperature is required between casting and riser to permit flow to continue until the casting has solidified. As is well understood, the riser as a feeding head is fulfilling a twofold purpose—it is providing liquid metal to offset the shrinkage taking place in the casting and is establishing a local region of high temperature in the casting to promote directional solidification so that the metal can be fed.

Frear[2] has conceived of a block-like growth of the dendrites, the blocky nature of the growth making feeding exceedingly difficult. On the other hand, if nucleation takes place in the central portion of a riser from inadequate temperature it can readily be conceived that such associations of atoms could greatly interfere with metal flow, preventing the riser from acting effectively.

Practical observation of the author has been that if sectioned feeding heads show large equiaxed regions, little feeding will have taken place. The provision of such risers with hotter metal—indicated by a more fully dendritic structure—has usually been effective in avoiding unsoundness in the casting.

The same reasoning applies to the casting itself. A casting showing considerable equiaxed structure adjacent to the feeding head will be fed only with difficulty, regardless of the inherent ability of the head to feed. As previously indicated, in heavy sections the effect of temperature gradient is small and an equiaxed structure is to be expected. Such castings are difficult to cast soundly, and the normal procedure is to cast as cold as possible in order to keep contraction to a minimum. With such practice little feeding

takes place from risers, the risers functioning almost solely as heat reservoirs.

Schwartz[6] went into the current theory of solidification quite thoroughly, and his paper is instructive in studying practical problems arising in the foundry.

External Influences

The problems discussed thus far have been concerned only with the physical behavior of solidifying metal, assuming the metal, as it lies in the pot before pouring, to be in an ideal condition for producing a sound casting. These problems are complex and, unfortunately, in a study of them it is exceedingly difficult to control the other variables that enter into, yet are not a part of, the freezing process. Gas, whatever the source, is the principle offender, and has long been a subject of discussion among foundrymen.

Of the gases, hydrogen appears to be the worst offender, in both ferrous and non-ferrous metals. A relatively high solubility in the molten state and low

The heat and mass flow analyzer in the A.F.S. Heat Transfer Project is expected to aid in brass and bronze feeding problems as well as those in other metals.

solubility in the solid state means that large volumes of gas may be rejected in the freezing range in melts which have been exposed to adverse atmospheres. Hydrogen, either as the element or combined, is present in copious quantities in melting atmospheres provided by gas and liquid fuels. With electric melting water vapor in the air can be disassociated at melting temperatures by carbon or carbon monoxide from crucible or lining materials, coke covers, etc., yielding free hydrogen.

Carbon monoxide has been strongly suspected in the past of being a cause of porosity. Current opinion seems to be that the carbon monoxide–water vapor reaction, which produces hydrogen, is responsible. The industry is indebted to Pearson and Baker[7] for clarifying this point.

Under the auspices of the Non-Ferrous Ingot Metal Institute, Eastwood and Kura[8] carried on rather extensive research on alloy 85-5-5-5. The work was centered chiefly about evaluating the test bars currently used in the United States and abroad. The inadequancies of the test specimens led the research into paths not anticipated at the start. The question that presented itself to the reader was not so much the inadquency of the test specimen but whether it is possible from present knowledge to design any casting which would be representative of the metal in the pot as the mold is poured.

Test Specimen Properties Differ

As is well known to foundrymen, a wide scatter results in pouring successive test specimens from the same pot of metal into supposedly identical molds. This scatter is normally attributed to faulty selection of test-specimen design. A point often overlooked is that there is just as much scatter in quality of castings made from the same heat and for the same reasons. Eastwood's suggestion of a larger number of test specimens per heat, although not economically feasible, would give a truer picture of the total lot of castings made from a heat than does the single test specimen.

The quality of the metal as indicated by the test specimen is usually considered as a measure of the degree of gassing of the melt. Badly gassed metal will show up in almost any test specimen cast under normal foundry conditions The gassing to be considered is generally taken for granted to be hydrogen. Obviously, the rejection of gas in the dendrites in the freezing range will interfere with feeding mechanisms, resulting in unsoundness and lower density in the casting.

In most of the work that has been carried out the effect of gas rejection has been considered only with respect to solubility at atmospheric conditions. However, in gas-free metal a virtual vacuum should exist in the voids opened up by simple freezing contraction. The Williams atmospheric riser postulates such low pressures and the effectiveness of the riser, especially for steel castings, gives excellent proof of this.

Inasmuch as gas solubility decreases with decreasing pressure in accordance with Sievert's rule, the gas dissolved in metal adjacent to voids developed through this freezing contraction will be rejected to a much higher degree than anticipated from knowledge of the solubility at atmospheric pressure. It must be concluded that any confined void developed through freezing contraction will contain rejected gas. The gas pressure will diminish with lowering gas contents of the melt, but will not be absent except in metal which is absolutely gas free.

Gas Determination Methods Needed

In line with the foregoing reasoning, zinc in the brasses and zinc-bearing bronzes can be assumed to vaporize into the voids at the low pressures involved, thus contributing a certain microsegregation to the alloys.

The question that arises is whether this rejected gas (or vapor) can be redissolved with sufficient rapidity to permit complete feeding to take place. The author, from observation of many bronze microsamples, doubts the probability of such resolution. In all the samples

examined, none has been found completely free from shrinkage of the sort variously known as incipient shrinkage or microshrinkage.

Included in the examination were the occasional test specimens showing exceedingly high physical properties. To the author this is one of the reasons why the as-cast properties never quite equal the properties of the same materials after being worked and annealed.

A major problem confronting metallurgists and foundrymen is that no good method has been developed for determining gas contents, either of a melt or of a casting of the copper-base alloys. Thus far the only study that it has been possible to make of the effects of the gases has been by subjecting melts to the atmosphere of interest and assuming full solution, whatever the solubility may be. Development of an analytical procedure would be of the greatest value in studying these problems.

Effects of Lead

In the work of Eastwood and Kura[8] attention was directed to lead distribution in the leaded bronzes, and an attempt was made to determine a factor governing the effects of lead on physical properties. Especially through the relatively new technique of microradiography, a great difference was found both in the size and distribution of the lead particles from melt to melt, and physical properties suffered rather markedly with adverse lead distribution. Further work on this problem is awaited with interest.

In 1931 Doughty[9] called attention to pinhole formation adjacent to cores in the bearing bronzes. As a result of various experiments, he attributed the pinhole formation to reaction of lead oxide in the metal with core binders. Such possibility was not touched on by Eastwood and Kura, although test specimens of excellent properties were produced, regardless of melting atmosphere, by pouring into molds baked at high temperatures.

Although Doughty[9] was concerned only with alloys containing 10 per cent or more of lead, and zinc additions aided the elimination of the pinhole defect, alloys of the 85-5-5-5 type commonly develop pinholes when cast in sands high in cereal binder. Since pinhole formation from this cause is not prevalent in the low lead (under 2 per cent) or lead-free bronzes (pinholes, of course, may arise from other causes), but becomes so as the lead content increases, it would appear that Doughty's reasoning can be extended to the 5 per cent lead alloys.

The role of lead is peculiar and, until Eastwood's work, little attention, according to published literature, has been paid to lead since Doughty's observations were made. Much further work is needed in this direction.

Melt Quality Defined

In the research work that has appeared, properties of castings have been predicated on an arbitrary "melt-quality." As generally implied, high melt-quality defines melts which are so low in deleterious gases and other impurities that the metal, as it is poured from the pot, is capable of producing superior castings if the molding sand and gating technique be correct.

This melt-quality is ordinarily measured by the properties shown in test specimens cast from the melt. As previously pointed out, inadequancies of the test specimens as a measure of melt-quality make for rather poor definition of this quality. Furthermore, a test specimen yields only a post-mortem measure of the quality of a heat, whether good or bad.

To overcome this a research project is now in progress at the University of Michigan, under the sponsorship of the Brass and Bronze Research Committee of the American Foundrymen's Society, for the development of a fracture test. By correlation of a fracture examination test with the properties of a physical test specimen from the same heat, it is hoped that a useful

A simple fracture test being developed on the Brass and Bronze Research Project will indicate melt quality in induction furnaces (above) and all other furnaces.

test can be developed which can be quickly performed and thus show the melt quality of a heat before the heat is poured.

Such a test would be of the greatest value to the bronze foundryman in the avoidance of rejects from melts which have gone off the track. This project has only recently been initiated and, although it is a difficult task, it is earnestly hoped that a useful test procedure will result.

Another cause for rejection of castings is included in that general term used by all foundrymen, "dirt." Dirty castings may result from a variety of causes. Here it is proposed to touch on only that variety which results from entrapped dross.

At normal pouring temperatures virtually all alloys oxidize readily in contact with the air. In most alloys the formation of an oxide skin is protection against further oxidation. If it is possible to form and keep intact a single oxide layer, clean castings will result (if other conditions are correct). In the usual running of a mold turbulence of the metal stream will cause breaking up of the first oxide layer and present fresh metal to be oxidized.

Thus, it is possible for large amounts of metallic

oxide to be entrapped in the casting; such castings are described as "dirty." All castings are susceptible to this type of defect, but in alloys which form refractory oxides of a density near that of the alloy such defects may become a serious cause of rejection. The aluminium bronzes produce clean castings only with the greatest of care because of the formation of the highly refractory aluminium oxide.

By avoiding turbulence and maintaining a streamline flow, the first-formed oxide skin will not break away to expose fresh metal, and this technique is an objective in sound gating practice. The mechanics of flow in bronze casting have been studied extensively at the Naval Research Laboratory, and a report on this work has been made by Robertson and Hardy[10]. The theory of turbulent and streamlined flow has been carefully considered and experiments have been performed to test the application of the theory. The underlying principles developed by Robertson and Hardy are a noteworthy advance and show the way for a great deal of valuable experimentation.

Conclusion

It has been the intention in the present paper to review the mechanics of solidification of the brass and bronze alloys and to touch on a few of the factors that interfere with normal solidification processes. Recent American investigations on these factors have been discussed, not from the standpoint of a critical review but more to indicate the present state of knowledge. There is no room for opinion in science. However, factual data have been neither presented nor discussed. The writer has endeavored to point out what is not known rather than what is known, in the sincere hope that someone, whether research worker or practical foundryman, will be inspired to follow up that spark of an idea which will help advance the foundry art to a true science.

Acknowledgment

Any ideas the author may have presented in this paper are the result of many experiments and of long hours of discussion with the foundry management of the Lunkenheimer Co. of Cincinnati, Ohio, who have fostered bronze-foundry research for nearly 50 years, and especially John Bolton, Director of Metallurgical Research and Testing, with whom the author was most closely associated and to whom the deepest gratitude is expressed.

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Steel Foundrymen Meet in Chicago

How to develop and maintain good industrial relations in the period of adjustment which all industry is facing was the subject of a two-day conference of the Steel Founders' Society of America, June 9-10, at the Drake Hotel, Chicago.

More than 160 top executives and personnel directors of steel foundries attended the meetings which covered labor legislation now pending before Congress, wages, labor contracts, plant safety and medical programs, increased productivity, supervisory and white collar employee relations and anti-discrimination laws.

Precision Casting Technique

The newly-developed Bendix technique of plaster casting produces castings in which machining and balancing are almost totally eliminated and can be applied to all non-ferrous metals on a mass production basis. The complex casting at the upper left is a turbine for a torque converter unit. Upper right is a ten-inch airplane landing wheel so accurately cast that only the hub requires machining. A two-pound saving in weight was made without sacrifice in strength. The third casting, a six-inch, two-stage shrouded impeller was cast in one piece with the vanes kept within tolerances of 0.005 in. The unit withstands peripheral speeds up to 1500 fps.

STOP METAL LOSSES AND WATCH COSTS GO DOWN

A. D. Barczak
Plant Manager
Superior Foundry
Cleveland

METAL LOSSES IN THE FOUNDRY have a pronounced effect on manufacturing costs as well as on the operating efficiency of the present-day casting industry. The manager of a foundry must deal with many problems that do not come directly under the headings of molding, dry-sand coremaking, melting, or cleaning castings. Although most managers understand these subjects, they must also be able to solve problems that come under different headings. Among these is the all-important one of the cost of castings and the various factors influencing this item.

To the manager, the purchase of metal, its manufacture and eventual sale on a pound or tonnage basis becomes a matter of economic balance, and the metal losses incurred in processing can become of such proportions as to wipe out any profit and cause the eventual bankruptcy of the business.

On the other hand the foundry superintendent must consider metal losses in a somewhat different light, although the eventual results must conform to a definite operating budget. The measure of his operating efficiency is to a great degree the percentage of yield he obtains through his manufacturing methods. In this discussion the percentage of yield is the ratio of tons of materials produced to tons of materials purchased and consumed during a given fiscal period.

After each daily heat has been run the superintendent should know how much and what kind of metals were used, how many pounds of good and bad castings were made, the amount of metal and coke left in the drop, how much iron was used for sprues and risers and the amount of molten metal remaining after the molds were poured. With this information he is able to compute the melting loss, the melting ratio, the percentage of good and defective castings made and the amount of metal needed for gates and feeders.

Inasmuch as metal losses in the foundry are of paramount importance to both the foundry manager and superintendent, it is apparent that a detailed study must be made of the sources of these losses.

Losses in the Metal Yard

From the manager's standpoint, care should be given to the buying, testing, condition and use of foreign or purchased scrap. The first precaution is to avoid mixed scrap. Insofar as possible, the purchasing department should buy scrap representing the same class of work in order to minimize the great variations in composition of commercial scrap.

It is not economical to use sorted scrap, or rusty scrap that has earth, concrete or any other undesirable material adhering to it. It is extremely important that all purchased scrap be weighed carefully to determine whether the correct amount of metal has been received for money expended. In all cases, a clear and explicit understanding should be reached with the scrap dealer.

As far as the foundry superintendent is concerned, the use of inferior scrap will produce operating difficulties, as well as a loss in yield, due to the charging of earth, concrete, etc. Of course, a shortage in weights of purchased scrap will mean that he will be charged for materials he has not received. It is important that he keep a vigilant eye on the type of scrap purchased.

Cupola Melting Losses

The melting practice employed is the sole responsibility of the foundry superintendent, and he must account for the losses incurred in this department. Usual practice in estimating metal losses is to allow about 5 per cent for over-all loss—charged metal against castings and returns. This includes dirt on scrap, etc. Actual or true melting loss is usually less than 5 per cent—probably about 2 per cent. Excessive melting losses can be attributed to high oxidization caused by rusty scrap, thin scrap, high blast pressures and a low and uneven burden in the cupola.

A poor make-up practice whereby the charges are weighed short or inaccurately because of inaccurate scales or the incorrect reporting of the number of charges put into the cupola will produce a fictitious metal loss or yield.

An improperly installed slag hole which burns out quickly or does not have sufficient refractory material

NOTE: This paper was presented at a Gray Iron Shop Course Session of the 53rd Annual Meeting, American Foundrymen's Society, in St. Louis, May 2-5, 1949.

above it to prevent iron dripping through will contribute a great deal to metal loss when melting is continuous. The poor practice of permitting the iron to accumulate to the full height of the well, mainly to burn out a too-viscous slag, will result in excessive iron losses through the slag hole unless a definite method is established to recover and properly weigh this iron before the slag is hauled to the dump.

Metal dripping at the cupola spout and receiving ladle, along with unnecessary splashing during metal transfer, will result in a great deal of spillage in front of the cupola. This is entirely unnecessary and is due to poor workmanship, and requires additional clean-up labor to recover the pellets and drippings.

Another source of metal loss in the cupola department, quite frequently overlooked, is the practice of permitting ladle skulls and metal in the cupola-drop to be hauled out with the regular foundry refuse. If this material is conveyed to a central knockout station and passed across a magnetic separator, the major portion can be salvaged for remelt purposes.

Pouring Losses

The practice of conveying and pouring the molten metal is determined by the foundry superintendent and his supervisors, and the skill and dexterity employed will greatly affect the amount of pouring losses. Of course, the lower the efficiency of this department, the greater will be the manufacturing cost. This should be brought to the attention of all supervision in the melting department by the foundry manager.

Molten metal is carefully transferred from the electric furnace into the bull ladle without the usual spillage and splashing that has so often characterized this operation in the industry in the past.

Molten metal is tapped into the mixing ladle. Proper spout contour and entire layout are conducive to a neat operation with little splashing or spillage.

Good foundry operation dictates that the molten metal on the first tap will be of sufficiently high temperature to be handled and poured without excessive pigging. The use of high temperature ladle heaters and covered ladles, along with well designed pouring cranes, will assist measurably in reducing the amount of metal that must be pigged, as well as scrap due to misruns caused by cold metal. The pigging of metal due to wet ladles is inexcusable in the modern foundry.

Again, unnecessary splashing during transfer from bull ladles to smaller pouring ladles will result in losses in the form of small metal shot which is seldom recovered. It would astound many of us if we were to carefully analyze this situation and determine pounds of metal lost in the daily foundry sweepings.

In the pouring operation, particularly with the continuous conveyor method, a great deal of metal may be lost due to spillage and splashing because of improper pouring bowl design or ladle lip contour. The pouring bowl may be too shallow or too narrow, while the pouring lip may be too wide. The monorail system on which the pouring ladle crane is propelled should be of such design that the ladle may be moved with ease, and the mold should be placed on the conveyor on a centerline uniformly distant from the centerline of the pouring loop.

The size and shape of the pouring ladles should be of major consideration so that a proper balance is maintained. The handling cycle should be of such nature that the pouring ladles will not have to carry heels of iron that must be pigged upon the completion of each pouring operation. Transportation of the molten metal, whether by overhead crane or by buggies on the floor, should be of such relative speed as to prevent excessive chilling of the metal that would render it unsuitable for successful pouring and thus necessitate pigging.

Pigging metal in sand piles instead of metal pig molds is a practice of the old-fashioned, inefficient, unkempt foundry of years ago. This practice can only produce uneven gobs of metal throughout the foundry, in addition to filling all floor-sand heaps with metal shot.

It can readily be seen that the combination of poor pouring practices and consequent metal losses will result in an exceedingly low yield as far as the foundry superintendent is concerned, and in exorbitant manufacturing costs in the eyes of the foundry manager.

Factors in Shakeout Losses

Metal losses in the shakeout operation can be attributed to several factors. In the case of floor molding, after the molds have been poured the loose iron on top should be taken off with a shovel or a pair of tongs and deposited in containers that can be transported to the cupola yard for remelting. If this is not done the spilled metal and shot will remain in the sand and eventually find its way to the dump in the excess sand that is hauled off the floor from time to time.

When the continuous molding conveyor method is employed it is important that the shakeout sand be conveyed by belt across a magnetic pulley. This will eliminate any manual operation and accomplish the separation of metallic particles and shot from the sand, and again this spilled metal can be hauled to the cupola

yard for remelting. Installation of a properly located electric light will enable the shakeout operator to see at all times that the magnetic separation is taking place and aid materially in metal recovery at this point.

To the foundry superintendent, metal losses that may occur in the shakeout operation will affect his yield to a certain extent; however, the most detrimental effect will be felt by the foundry manager because of the fact that this hidden leak or steady flow of metal shot in foundry refuse to the dump is usually not discernible unless someone in the organization makes an investigation to find out what these losses are. A constant check by all supervision in the foundry is absolutely necessary to minimize these losses.

Losses Due to Grinding and Cleaning

Castings come from the sand with more or less sand adhering to them. It is generally good practice to run the cooled castings over a vibrating knockout screen. It is at this point that the remaining gates and risers are usually knocked off and recovered. The castings remain on the screen until the cores are completely disintegrated, which will allow the recovery to a large degree of core rods and wires that can be straightened and reused in the core department. All of the material passing through the knockout screen should be conveyed by belt across a magnetic pulley to recover all metal at this point.

The gates and risers on cast iron can be removed by flogging, sawing, chipping, or sprue cutter. After the gates and risers have been removed the castings may be cleaned by tumbling, sand blasting, metal shot blasting, or sand-water blasting.

When castings are cleaned by the tumbling method, it is important that they be not milled too long or the sharp corners and bosses will be worn down to such an extent that dimensional tolerances will be lost. Although it may seem trivial, the loss of one ounce of metal per casting will amount to considerable tonnage during the course of a year. The shipment of castings having nail slivers or mill stars in the interior cavities is another avenue for unaccountable metal losses.

If the metal-shot method is employed for cleaning castings, care must be taken that the castings do not remain too long in line with the flight of the shot. The highly abrasive action of the metal shot will, as in tumbling, cause the castings to lose weight, and this will be reflected in a considerable tonnage loss. The same holds true for the sand blasting method to a lesser degree.

Recover Metal Shot

A close inspection should be made prior to shipment to insure the complete removal of metal shot from the inside of all castings. One need only pick up a handful of this shot to realize how heavy it is, and a complimentary sample in each casting shipped to the customer will result very quickly in the complete disappearance of the shot from the cleaning system. The recovery of the metal shot from the cleaning room floor by sweeping or industrial vacuum cleaners will quickly justify itself.

After the sand has been removed from the castings the small remaining pieces of gates and risers or fins are either chipped or ground off. The chipping operation should be conducted within a confined area so that the chips may be swept quite frequently and deposited in containers to be sent to the cupola yard. Where grinding is employed extreme care must also be taken in that excessive removal of metal at the gate and riser pad will destroy the casting contour and cause an ultimate loss in casting weight, along with the possibility of casting rejection due to dimensional discrepancies.

Casting Design May Cause Metal Loss

A well-designed casting is not only mathematically but also metallurgically correct. Stress analyses calculations and metal quality specifications mean nothing unless sound castings can be made economically according to the design. A design may be defined as a form or shape so conceived that if made of suitable material it will perform a useful service. The best design is that from which a satisfactory structure can be made most economically.

Economy dictates certain limits in dimensions, weight and choice of materials. Mechanical and often

chemical factors must be considered. Obviously the casting must maintain its shape, resisting the applied stress and corrosive influences to which it may be subjected. Often unnecessarily large factors of safety are used in designing castings because of the fear of unsoundness. The necessity for such large factors of safety has been, in most cases, the joint responsibility of the designer and the foundry superintendent.

It is quite rare for a part to fail due to insufficient section size. It is not rare, however, for failures to occur due to stress concentration, porosity, shrinkage, hot tears and cracks as a result of poor design. Therefore, it is absolutely necessary that the designer and foundry superintendent cooperate closely to make certain that the design of the casting will give the greatest service with the least weight.

Whenever the foundry superintendent endeavors to produce castings of a faulty design he encourages metal loss and low yield because of the strong possibility of producing scrap in his own foundry as well as additional failures in the field. The foundry manager also

violates a good business rule by permitting the sale of castings of a heavier design than needed to do the job well.

Pattern equipment with worn or warped plates will produce cope and drag surfaces that will not meet correctly upon closing the mold, resulting in a fin of excess metal and, in many cases, runouts. Warped and bent flasks will also produce the same type of metal losses. Warped and inaccurate jackets will result in runouts and swollen castings. Excessive draft and finish allowances on a pattern will produce castings with extra metal that generally is not required. Excessive core fins and core vents that are filled with metal make up an astounding metal waste in the average foundry which has a relatively high percentage of cored work.

Losses Due to Pattern, Core Box and Flask Equipment

A good practice in pattern construction is to make the core prints larger than the cored opening. This prevents cracks formed in the cored openings by fins along core prints in usual type of pattern construction and their elimination by the step method of core print construction. Keeping the crush strips on core prints to a minimum dimension at the tangential point of the core print and the mold cavity will also reduce excess metal. Uniform crush grooves worked into the core prints or the use of paste around the prints will prevent the molten metal from entering into the core vents. This will not only prevent the possibility of high scrap loss due to blows, but will save a considerable amount of metal, the loss of which is usually not detected in the regular foundry operation.

In the construction of a pattern, careful consideration must be given to its use by the molder and coremaker. Allowance for the placing of heads and gates must be made in the construction of core prints, use of loose pieces, etc. Cooperation between the consumer, patternmaker and molder often spell the difference between a poor casting and a good one. With regard to this phase of foundry operation, it becomes the duty of the foundry manager to see that the foundry superintendent is furnished with good patterns, core boxes and flask equipment, and then it becomes the foundry superintendent's job to produce castings and eliminate the poor practices just mentioned.

Gating and Risering May Cause Metal Loss

The method employed by the foundry superintendent in gating and risering a given job will have a great deal to do with whether he attains a yield of 45 or 60 per cent. To the layman or apprentice foundryman the gating and risering of castings appears to be an involved process. Actually, it is not difficult, requiring mainly the application of common sense and a few well-known principles. The violation of these principles will result in high scrap and excessive metal losses. A frequent review of the gating and risering of all the jobs in production and making the proper corrections will assist greatly in keeping the yield at a high level.

The primary principle to be kept constantly in mind is that molten metal solidifies as a continuously thickening envelope or skin. The initiation and progressive formation of this skin is caused by heat absorption into and through the mold. For a given metal and mold material the rate at which this solidification takes place is governed largely by the relation between the section mass, or volume, and the mold surface area. All metals contract in volume in varying degrees upon cooling and upon solidification.

If this contraction in volume is not considered, shrinkage voids will occur in the castings. To prevent this, reservoirs of metal, in the form of risers, should be provided at selected spots to supply molten metal to the casting as it cools and solidifies. The foregoing principles should be thoroughly understood before attempting to make a particular casting. Once understood and applied, proper gating and risering will be possible and sound castings will result.

Selecting Gating System

Gate systems function primarily as a means of introducing metal into a mold. Selection of the gating system is based upon three factors:

1. Need for complete filling of the mold.
2. Avoidance of mold damage by the liquid metal.

◀ Molds are properly spaced on the conveyor with the pouring bowls at a uniform distance from the centerline of the pouring loop.

Efficient, well-balanced continuous pouring operation. Note the simplicity of design, lack of splashing of molten metal during the pouring, and the absence of iron drippings as indicated by the cleanliness of the floor at this pouring station. ▶

3. Establishment of proper temperature gradients, so that the gate is not responsible for shrinkage voids in the casting.

To achieve these aims, steps must be taken to control the following:

1. Type of ladle and ladle equipment used.
2. Size and type of sprue or runner gate used.
3. Size, number and location of gates entering the mold cavity.
4. Rate of pouring.
5. Position of the mold during casting.
6. Temperature and fluidity of the metal used.

In planning the type of gating system to be used for a given casting, it is necessary to apply the principles previously mentioned, selecting the number, type, size, shape and location best suited and most convenient to use in filling the mold at the desired rate. Gates should be so arranged that erosion, trapped air, hot tears and shrinkage cavities will be avoided, and for ready removal in cleaning.

A riser on a casting must function as a reservoir of heat and molten metal and, to be effective, it must be

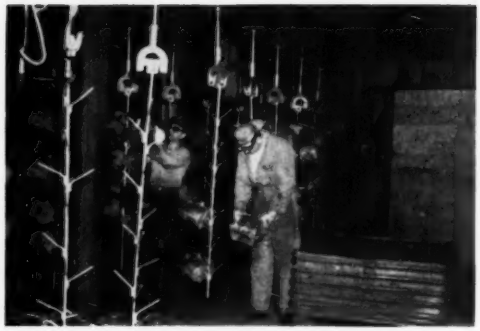
The modern coreroom is equipped with core blowers and continuous vertical ovens. A high percentage of reclaimed core rods and core wire is used here daily.

the last portion of the casting to solidify. There are four primary requirements which a satisfactory riser should meet:

1. Riser volume should be ample to compensate for the metal contraction within the area of the casting it is designed to feed.
2. Fluidity of the metal in the riser must be such that it can penetrate to the last contraction cavity within its sphere of influence.
3. Contact of the riser with the casting must fully cover the area to be fed, or be so designed that all the needed feed metal in the riser will pass into the casting.
4. The riser should be effective in establishing a pronounced temperature gradient within the casting, so that the casting will solidify directionally toward the riser.

Accordingly, the shape, size and position of the riser must be effectively controlled.

Castings may be considered poorly designed ingots,



After cleaning by shot blasting, the operator is carefully removing metal shot from the casting interior.

and the soundest ingots are made with the big end up, thus promoting directional solidification. Likewise, the ideal casting is one which can be fed from one riser, with the sections tapering down from the risered section. Such designs are comparatively rare in the foundry; there usually are many isolated heavy sections. All of these heavy sections must be fed by risers or chilled by the use of internal or external chills. Each section should be considered as the center of a system, and each must be risered for proper feeding.

When castings are not properly risered shrinkage will occur in the heavy sections or hot spots, with the adjoining metal sound because it was fed by the liquid metal of the last section to solidify.

In almost all designs, and with all methods of gating and risering, there is some auto-feeding, i.e., the liquid metal still flowing into the mold compensates for the contraction of the metal already present and chilled by the mold surfaces. It is possible, theoretically, for castings to be fed by the sprue alone, the heat being extracted from the molten metal by the mold walls at such a rate that each successive increment of hot metal feeds the resulting shrinkage progressively as it fills the mold. It is not possible to apply this principle practically to obtain a perfectly sound casting, but by using the proper gating and pouring technique the condition can be approached.

Incidentally, failure to recover internal and external chills that have been used in conjunction with risers from the sand after a casting has been shaken out can frequently be the source of metal losses if such sands are not passed across a magnetic separator.

It can readily be seen that the improper application of gating and risering will result in a low yield. This has a direct bearing on the foundry manager's ability because it increases the manufacturing costs due to the greater number of man hours required to produce a given tonnage of castings.

Dust Collector Iron Losses

In casting cleaning it is necessary to provide means for the collection and disposal of dust. Many different names and designations are given the various types of equipment used for this purpose, namely, dust arrestor, dust collector, dust filter, air filter, and air washer.

The methods used are further divided into "dry"

and "wet" method. They are all referred to as dust collectors, as the ultimate aim is to collect the dust no matter what means are employed. A close examination of the dust will show that it contains a certain percentage of iron particles. Excessive milling, blasting, swing grinding and stationary grinding will tend to increase the iron content of the dust.

Inasmuch as this iron cannot be recovered it becomes a complete loss. Therefore, it is important that the foundry superintendent keep a watchful eye on his general cleaning practices. Although this may seem to have little effect on the foundry costs, close observation over a period of time will reveal that tons of iron can be lost through dust removal, and will bring to light another hidden variable that has a pronounced effect on the manufacturing budget.

Alloy Losses

To those foundries which specialize in a wide variety of alloy cast irons, it becomes of prime importance for them to segregate carefully the gates and remelt of various compositions. Generally the customer buys on a pound basis the alloying elements that are required in his specifications; therefore, it is a matter of necessity for the foundry superintendent to see that the gates, sprues and risers of a given composition be recovered for similar subsequent heats, thus curtailing the necessity for repetitive high alloy additions to derive the same chemical compositions.

Failure to do so will result in complete loss of the elements through dilution in the general mix, for which no additional revenue can be derived, plus the strong possibility of creating scrap due to improper metallurgical structures which can result from unidentified alloy compositions.

Castings sold on a piece-price basis should be checked frequently to see that they do not vary from the accepted and approved sample weights from each customer. Overweight castings that are the result of swells, metal penetration, fins or other distortions, mean that metal is being given away without corresponding revenue, and must be considered as a metal loss as well as a financial loss.

Conclusion

The many avenues of metal losses as indicated in this paper warrant a detailed evaluation, which should comprise a worthwhile job for a highly responsible individual in the foundry organization. A 10 per cent metal loss, when considered on an incoming and outgoing basis, will result in a corresponding increase in metal cost. This same metal loss will also affect the yield to the extent that the man hours per ton of castings produced will be increased approximately 10 per cent, and the combined effect of these two will be an approximate 7 per cent increase in the total manufacturing costs. This certainly deserves the close scrutiny of everyone connected with the industry.

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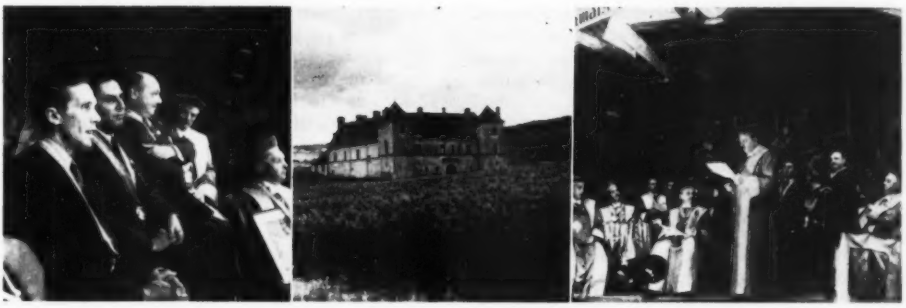
Burgundy Wine Tasters' Association Honors French Foundrymen



Members of the Eastern French Foundrymen's Association, meeting for their Annual Congress at Dijon, capital of the wine-producing province of Burgundy, were guests of the Confrerie des Chevaliers du Tastevin (Knights of the Wine Tasters' Association) at the Chateau Clos de Vouget, home of world-famed vintage wines. Several prominent French foundrymen were appointed Chevaliers of the Confrerie in an elaborate and centuries-old ceremony. The Confrerie was created in the Middle Ages to bring recognition to the red wines of the province, and today has about a thousand members scattered throughout the world, among them 42 Americans. At left in the photograph above are a few of the foundrymen who were honored by the Confrerie. Center: Clos de Vouget, built in the 13th Century. Right: P. Balland, president of the Eastern French Foundrymen's Association, an organization created in the 11th Century, reads an address of acceptance for the French foundrymen so honored. (Photos and story courtesy A.F.S. Member R. Dureil of Paris.)

QUALITY CONTROL REVIEW...

Summarize Test Procedures for Malleable Foundrymen

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Five papers, sponsored by the Annual Lecture Committee of A.F.S., were presented at Lecture Course Sessions of the 52nd Annual A.F.S. Meeting. In this issue, test procedures for quality control in the malleable iron foundry are described. Of other papers in the series, steel was published in the January, 1948 issue of *American Foundryman*, and gray iron, brass and bronze, and aluminum and magnesium will appear in future issues.

MALLEABLE IRON CASTING PRODUCTION cannot be classified under any standard operations. Processes used in the industry vary greatly in all departments, including melting, core making, molding, cleaning, annealing, processing and engineering.

Scrapped castings are generally the result of improperly controlled manufacturing methods. It is hoped that this discussion of the factors which directly affect the quality of castings will interest many foundries to the extent that those not operating under controls will install some method of procedure by which each detail of the foundry manufacturing process can be recorded and controlled. It is realized that there are many variables in the foundry, and that even with controls on all raw materials, processing and inspection, it is difficult at times to maintain a quality product.

One of the first requisites of good control is the purchasing of all raw materials from a reliable source. Unless this is done, an adequate technical force must be maintained to check 100 per cent on all incoming materials, which is both costly and impractical. Even so, periodic checks must be made to insure that raw materials are within the foundry standards.

Presenting the data in sequence, a start will be made with the control of incoming raw materials. It is not the purpose of this presentation to describe any of the methods used in the control of various processes—suffice it to say that all methods used should be standard and approved by the ASTM and A.F.S.

Check Raw Materials

Tests on raw material which it has been found advisable to make are the analyses of pig iron for various elements such as carbon, manganese, silicon, sulphur, phosphorus, chromium, copper, and molybdenum. The microstructure of the pig iron is also checked as it has been definitely proven that the size and shape of graphite in silvery iron has a direct relationship to the carbon nodules in both malleable and pearlitic malleable iron.

Steel scrap is checked for excessive amounts of residual elements which will affect the graphitization of the metal in both the hard and annealed state. Most important of these are chromium, tin and aluminum, of which chromium is the most likely to cause trouble due to the fact that it occurs in many steels.

Coke and limestone for cupola operation are purchased to conform to definite and uniform specifications. Coke is checked not only for chemical analysis, but also size, strength, and cleanliness. Analyses are run on coke for the following: fixed carbon, volatile matter, sulphur, ash, percentage of cellular space, moisture, Btu., screen test, and shatter test. It might be interesting to add that the foundry coke supplier has set up at his coking ovens a pilot cupola in which he duplicates our operation, thereby satisfying himself that he is sending uniform coke from day to day.

All core materials are checked—sand as to grain size, shape and number; core oil for its specific gravity, saponification number and viscosity. Cereal binders are checked for density and green compressive strength. Seacoal and clay used in molding sand are also controlled. This covers briefly the most important of the controls on incoming raw materials.

For the control of the molten iron, irrespective of the melting method employed, some limits of chemical analyses must be set up for control purposes only. The two principal conditions to be met in the production of salable iron are: (1) ability of the iron to attain proper strength; (2) good machinability after heat treatment. To pass this test, it is usually necessary for a test bar produced from the heat to show certain minimum physical properties.

A regular round tensile bar is used for checking and evaluating the quality of the iron. The bar used is 7 in. long, with the central test portion 0.625 in. in diameter. The ends of the bar are 1 11/32 in. in diameter for a length of 5/8 in. This facilitates the loading and holding of the bar in the tensile machine. The bars are poured on a production line and placed in the kiln along with castings. After annealing they are wire brushed, measured, and then tested. The yield strength, ultimate strength, elongation and Brinell hardness are obtained. The bars are not machined.

Frequent use of the microscope as a check on the practice, and the effect of raw materials on the practice, cannot be stressed too greatly. A variation in the physical properties of the metal in some cases can readily be explained by examining the microstructure. Likewise, raw materials that appear to be usable on the basis of chemical analysis may prove otherwise when checked with the microscope.

It is true that there are conditions other than the nature of the iron which can produce mottled iron castings. The cooling rate of the castings in the mold directly affects the mottling condition. It is also necessary to control pouring conditions such as iron temperature, cooling rates, and other variables. While

test bars are valuable in the control of quality, the author knows of no better test than a periodic breaking of castings under average conditions to inspect for mottle and soundness.

For close control preliminary chemical analysis should be taken for carbon, silicon, and manganese, and a sufficient number of tests should be taken to guarantee a uniform iron going into the mold. Final analyses of each heat, or at certain intervals throughout the day, should be run on the aforementioned elements. The author finds it advisable to run preliminary analyses on each cupola at 30-min intervals, and also to take a final analyses from each furnace at least every 2 hr.

Pour Test Sprues

In addition to this test, sprues are broken from each furnace approximately every 15 min. The test sprue size to be used is determined by size of the castings produced. In automobile malleable iron a sprue of 2-in. diameter and 8- or 9-in. length is of satisfactory size. The sprue is poured into a core sand mold and allowed to cool to black heat, quenched in water, and broken. The fracture should show few if any primary graphite spots. Since chromium is considered a vicious element, once a day, or more often if necessary, this element is run and maintained under a predetermined maximum. Sulphur is also kept within close limits.

Temperature control is maintained at the melting unit and throughout the pouring operations. Good pyrometers are available, and there is no reason for not installing adequate temperature control equipment. Control of blast volume and pressure is necessary for the successful operation of the cupola in duplexing practice.

In air furnace melting, maintaining a proper furnace atmosphere (atomizing or mixing of fuel and air) calls for certain standardizing and control of the mixture. In cupola duplexing, both hot blast and humidity control are valuable aids in obtaining uniformity.

When a cupola is used for the manufacture of malleable iron, either as a single unit or in combination with air or electric furnaces, control of the cupola operation has a major effect on the quality of the final product. Construction of the cupola, which includes ramming the bottom, building the well, construction of tap and slag holes, tuyere openings, and proper relining of the melting zone are important control factors. It is also important that the height of the coke bed and the order and nature of the charge be standardized according to a predetermined practice.

Make Proper Furnace Repairs

In the operation of the air furnace there are numerous and important rules to follow in order to produce uniform metal. Furnace repairs must be properly made. These include the bottom, tap hole, side walls, roof, bridge wall, and the furnace throat leading to the stack. Charging of the air furnace should be standardized and fuel consumption should be checked and kept under constant control.

The electric furnace generally is used as a holding furnace. It is also used as a means of refining the iron, as any cupola analysis which is outside the limits can be corrected at the furnace. The bath level should be kept constant and either slag-free or under controlled slag. The electrical equipment must be in perfect order to hold carbon pick-up to a minimum. Records should be kept of the kwh per ton. All pouring and transfer ladles and holding forehearths, if used, should be of standard design and construction in order to obtain the longest life and produce the highest quality iron. The following details should be considered: (1) mixing of ladle lining material; (2) ramming of the ladle lining material; (3) thorough drying and preheating to eliminate moisture.

The human element involved in making the mold is the cause of much foundry scrap. It is important to produce molds of the same hardness hour after hour; therefore, automatic jolting is one factor found to be advantageous in eliminating variations in the number of jolts. The amount of squeeze is another variable which should be controlled. Proper maintenance of flasks, molding machines and patterns aid in eliminating excess scrap.

Molding sand is checked periodically for moisture, permeability, and bond strength. The temperature of molding sand is important in order to prevent the sand from sticking to the pattern and producing dirty castings. The temperature of the sand is kept to a minimum. Other control tests to be made daily, or as often as necessary, are dry compressive strength, green tensile strength, sand distribution curves, and percentage of seacoal and clay. In the author's plant the operators of the sand units are paid on the basis of keeping the sand within certain moisture limits. This places a premium upon good sand control.

Control Mechanized Molding

On a mechanized molding unit, it is important that all operating details be closely controlled. Some of these are: (1) condition of muller and muller blades; (2) clay and seacoal feed arrangements; (3) regulating the amount of spill sand to the proportion of shakeout sand; (4) condition of screening equipment and the revivifier.

The first step in controlling and maintaining a uniform core sand mixture is to start with a dry sand. In the operation of the mixers it is important to carefully weigh or measure all ingredients. Duplication of a given core sand mixture calls for standardized mixing practice. This can be accomplished by controlling the sequence of additions to the mixer and the total mixing time.

Once a certain core mixture has been worked out for a particular job, the physical properties are determined through standard methods and the process checked regularly. These checks should include tests for green compressive and baked tensile strengths. The baked tensile strength test is carried out in the standard laboratory oven, as well as in the production oven, as this will give a check on both mixture and baking conditions. Operation of the core ovens is checked as to the time of the heat, temperature, loading, and other operating details.

Many good heat-treating practices are in use, varying according to the type of iron and the heat-treating equipment available. Uniform temperatures must be maintained throughout the charge if the anneal is

to be satisfactory. Good pyrometric equipment is necessary, and thermocouples must be checked frequently against tested standards. Once a satisfactory annealing cycle has been established it should be maintained.

In the operation of atmosphere-controlled radiant-tube ovens it is necessary to run gas analyses in order to maintain a proper atmosphere.

A certain amount of control is required to maintain proper equipment in the processing of the castings. Shear knives, milling cutters, or broaches are used in the removal of gates. The quality of these tools is checked. The blasting and milling of castings should be studied with a view of obtaining a satisfactory clean casting in the least time. The control of these operations is a function of the surface condition of the casting, together with the type of equipment used.

One phase in malleable casting production which should be given full consideration when setting up controls is that the job be properly engineered. After the gating layout has been determined it should be adhered to, and no changes made unless the job shows excessive scrap.

A record should be kept of the original layout and any changes made, so that if the job is out of the sand for a time it can be replaced with complete information at hand. In the author's foundry detailed prints are made on all job layouts, and changes are incorporated as soon as made. Some plants take photographs or make sketches of all new jobs as soon as satisfactory gating has been developed. Cores and chills are also sketched and photographed. We maintain a case history of each job, with the following data which serves as valuable information for that particular job:

(a) Data on molding mixtures.
(b) Data on core sand mixtures.
(c) Analyses of the scrap as to cause and percentage.
(d) Weight of iron in mold.
(e) Weight of rough casting.
(f) Yield of good castings.
(g) Changes made in a pattern equipment or gates and risers.

Inspection control can be augmented by the use of x-ray or radium. Both can be of use in developing proper gating. Numerous plants use magnetic particle or fluorescent magnetic particle methods to inspect castings for cracks. Cutting up castings in both the hard and soft states, and etching the pieces in acid is probably the most satisfactory method of checking the soundness.

In conclusion, it may be said that if proper care is taken in the first steps of the foundry practice, such as raw material and melting practice checks, much of the necessity for checking castings in the later stages of manufacture can be eliminated, or at least minimized to the point where a close check is not necessary. In other words, a good start insures a good, sound, quality casting.

Recent OSU Graduates Compare Notes On Foundry Industry

Recent graduates of Ohio State University now in the foundry industry returned for a breakfast get-together during the 2nd Ohio Regional Foundry Conference, March 11-12, in Columbus. Expected to be an annual affair, this year's meeting was arranged by Gail M. McCleary, Superior Foundry Inc., Cleveland, who graduated a week after the picture was made. Several of these young foundrymen have been A.F.S. members since joining the OSU Student Chapter as undergraduates. Left to right are: David M. Paisley, U. S. Radiator Corp., Detroit; Harry Placke, G.H.R. Foundry Div., Dayton Malleable Iron Co., Dayton, Ohio; Mr. McCleary; Robert Wilson, Ohio Malleable Iron Co., Ray Patridge, Bonney Floyd Foundry, and Harry Grable, Ohio Malleable Iron Co., all of Columbus; Robert McCormick, General Foundry & Mfg. Co., Flint, Mich.; and Prof. R. P. Schneider, Ohio State University. Photo by Wilford H. White, Jackson Iron & Steel Co.

HEAT TRANSFER... A FOUNDRYMAN'S TOOL

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Heat and Mass Flow Analyzer Laboratory
Columbia University
New York

THE ENTIRE WORK OF A FOUNDRY is based on heat. The foundryman uses the words heat and temperature continuously, and yet he stops only rarely to consider the basic relationships. In fact, because heat is so intangible, most foundrymen seem to avoid systematically studying heat problems. This is unfortunate, because successful foundry practice is possible only if one is able to control successfully the heat processes.

In the first part of this paper the elements of heat flow are presented in simple and readily understandable terms. In the second part, foundry practice will be looked at from the thermal viewpoint. In the third part the electric analogy method is briefly explained.

Elements of Heat Flow

Temperature and Heat Content—In every-day language these two terms are too often confused with each other. It is essential to distinguish between them.

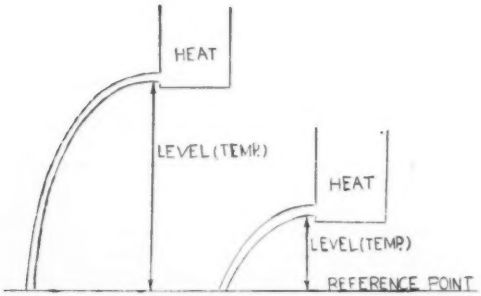

Fig. 1 — Heat content at different temperature levels.

Temperature is an expression for a level and is meaningful only if compared with a reference point. This reference point in the case of the centigrade scale is the melting point of ice. In the case of the Fahrenheit scale it is an arbitrary point 32 degrees below the melting point of ice. Finally, from physical considerations the concept has been established of an "absolute zero," which lies at —460 F.

The various temperature scales do not concern us here, but it is important to remember that there always must be a reference point for the temperature.

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Figure 1 illustrates two containers of equal size "full of heat"—but they are at different levels, i. e. at different temperatures. In Fig. 2 again two different temperature levels are shown, but on each level there are two containers of different size, indicating different heat content. This different heat content can, e. g., be caused by different weights: 1 lb of steel heated to a certain temperature has half the heat content as compared to a second piece, heated to the same temperature but weighing 2 lb.

The heat content is measured in "Btu" which is the abbreviation for "British Thermal Unit." One Btu is the quantity of heat required to raise the temperature of 1 lb of water one degree F (or, precisely from 32 F to 33 F). Figure 3 is a graphic presentation of the definition of the Btu.

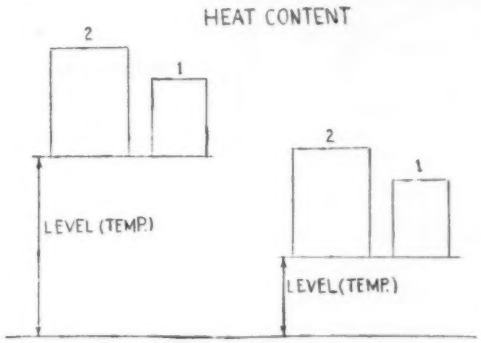

Fig. 2—Heat content in different size containers.

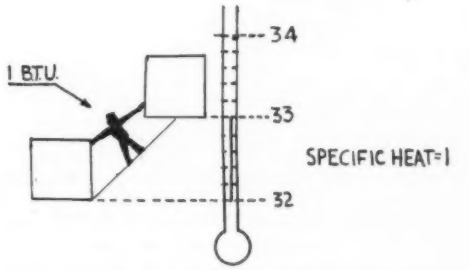

Fig. 3 — Graphic definition of British Thermal Unit.

In the metric system the heat content is measured in calories. We must remember that heat is one form of energy, and therefore it would also be possible to express heat quantities in watt-hours or in foot-pounds.

Specific Heat—Suppose in Fig. 3, water is supplanted by a different material; this material is such that less heat is needed to raise the temperature one degree. This is indicated in Fig. 4 by showing one half of "Mr. Btu," for a material with a specific heat of 0.5.

The specific heat of a material indicates how many Btu are required to raise the temperature of 1 lb of a substance one degree F.

The specific heat of water is one; that of all other substances is less than one. The specific heat of iron or steel is in the order of magnitude of 0.11 Btu/lb,F at room temperature and approximately 0.15 near the melting point.

Rate of Heat Flow—The term "Rate of Heat Flow" is almost self-explanatory. It indicates how many Btu flow through a given system per hour. Figure 5 again

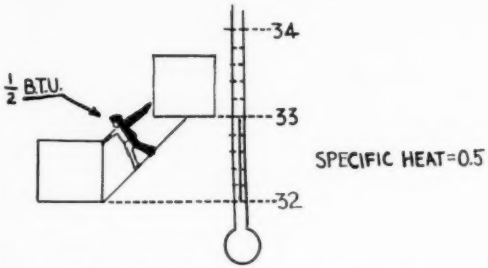

Fig. 4 – Specific heat defined graphically.

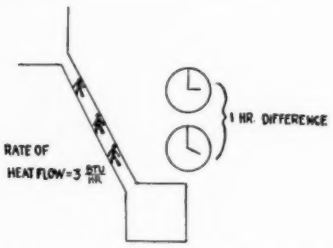

Fig. 5 – Graphic definition of rate of heat flow.

illustrates the definition graphically, reminding at the same time that heat flow can occur only under the influence of a temperature difference, hence the difference in level between the left and the right tank.

Frequently it is convenient to refer the rate of heat flow to the area; e. g., one may ask "how many Btu per hour and per square foot are transferred through the surface of a casting into the mold?" This rate will obviously vary with time, but it is a good example of the significance of the term "rate of heat flow."

Thermal Conductivity—Thermal conductivity is a measure of the insulating property of a material. High thermal conductivity (metals) means that the material is a poor insulator.

The conductivity is expressed in Btu/sq ft, hr,F per ft, or more concisely by Btu/ft,hr,F.

It indicates what the rate of heat flow (Btu/hr) is across a thermal barrier with 1 sq ft of cross-section and 1 ft thickness, if the temperature difference across the barrier is 1 degree.

This rather cumbersome definition can be illustrated by Fig. 6. The tube of the funnel (on the left) has a cross-section of 1 sq ft and a length of 1 ft. If a rate of heat flow of 1 Btu/hr results under the influence of a temperature difference (at the ends of the tube) of ($a = 1/k$) degrees Fahrenheit, then we say the tube (illustrating the thermal resistance) has a conductivity k.

If (right part of Fig. 6) the cross-section of the funnel is reduced to ½ sq ft and the conductivity, k, remains unchanged, then we must apply twice the temperature difference ($b = 2a = 2/k$) in order to obtain the same rate of heat flow (1 Btu/hr). Similarly, if we restore the old cross-section, 1 sq ft, but double the length we would require again twice the initial temperature difference $2a = b = 2/k$ to obtain the same rate of heat flow.

With the original set up (1 sq ft cross-section, 1 ft length, conductivity k), we would need $3a = 3/k$ de-

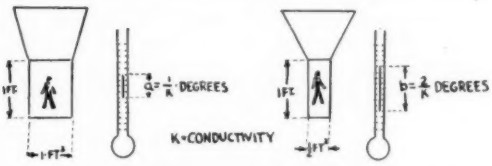

Fig. 6 – Graph illustrating thermal conductivity.

grees temperature difference to obtain a rate of heat flow of 3 Btu/hr.

Conductivity can also be so explained, that if a rate of heat flow of 1 Btu/hr results in a body of 1 sq ft cross-section, 1 ft long under the influence of one degree temperature difference, then the body has a conductivity equal to one. If under this temperature difference a rate of heat flow of k Btu/hr obtain, then the conductivity is k. And if the temperature difference then is made t, instead of one degree, the rate of heat flow will be t·k.

The thermal conductivity of steel is in the order of magnitude of 25 Btu/ft,hr,F, that of sand in the order of magnitude 0.4 Btu/ft,hr,F.

Heat of Solidification—The last concept of heat flow with which the foundryman has to deal is that of heat of solidification (or heat of fusion). Talking first of pure metals, as heat is supplied to a piece of cold metal the temperature gradually increases, as is obvious from our concept of specific heat. Then at a given temperature (i. e. the melting point) even with further supply of heat, the temperature rise stops for a while and starts only after a finite interval of time. During this finite interval of time the heat of fusion (or the heat of solidification) is added to the metal.

This heat of fusion can be presented in a schematic manner by a heat "scale" measuring (if that were actually possible) the heat content (Fig. 7). In each of the two trays of the scale is put 1 lb of aluminum; one (left) pound being solid, indicated by (1220—) (showing that the temperature is just slightly below the melting point); the other pound being liquid, indicated by (1220+) . . (showing that the temperature is just slightly above the melting point). The heat "scale" shows greater "weight" (heat content) for the liquid aluminum. Most industrial metals are not pure, but compositions of several elements, and hence do not solidify at one value but over a given range. The heat of solidification starts to be freed at one temperature known in metallurgical terms as the "liquidus," and the generation of the heat of fusion is terminated when a lower temperature (solidus) is reached.

Thermal Problems in the Foundry

It is possible to draw a schematic flow diagram of operations in a foundry using sand molds (Fig. 8). The operations in which heat problems occur are marked by an asterisk.

Because of the variety of melting furnace types used in foundries, furnace problems will not be discussed here; but it is well to remember that the melting equipment in use today is far from being thermally perfect.

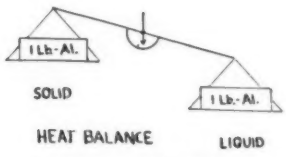

Fig. 7 — Schematic diagram illustrating heat of fusion.

The ladle—lined or unlined—offers a number of thermal problems. Take, e. g., a receiving ladle. Figure 9 shows the drop in average temperature plotted against throughput. The shape of this curve will actually depend on the nature and thickness of the lining and also on how the throughput is achieved: whether the ladle is partly filled many times per hour, or less frequently completely filled; also, of course, on the temperature at which the ladle is filled, and on the nature of the cover, if any.

Returning now to Fig. 8, one finds mold and core drying are next on the list of thermal problems. In fact they are very complex problems, because the heat flow problem is closely linked to the flow of fluids either liquid or vapor, and these generally flow in a direction opposite to that of the heat and thus partly counteract it; as the heat wave penetrates toward the center of mold or core the temperature rise results in an at least partial evaporation of the moisture (water or oil); the vapors migrate toward the cold outside, thus transporting heat back.

In a proper heating cycle for drying no overdrying at early stages should take place, lest a hard crust be formed which might result in crushed outside shells.

In Fig. 10 two different time-temperature curves for the surface of a core are shown. In case of the more rapid rise the surface is dried out before the moisture from the inside can escape. Consequently, as the heat penetrates to the inside, the developing pressure finds no way out but by cracking the surface. The slow rise prevents complete drying of the surface prematurely.

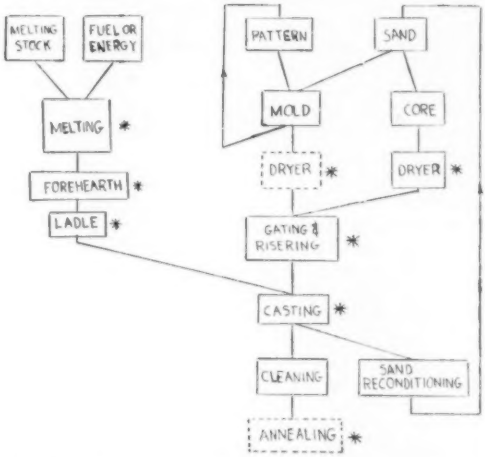

Fig. 8 — Schematic flow diagram of foundry operations.

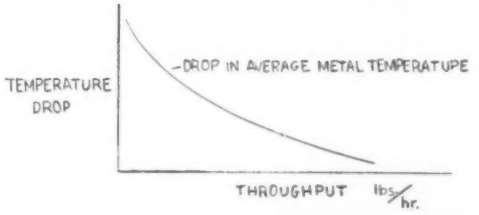

Fig. 9 — Curve showing temperature drop in ladle.

As in the case of the ladle, a practical solution will in many instances probably be found by the foundryman. But new conditions—unaccustomed dimensions, new materials, etc.—will be best met by recognizing and handling a problem as a thermal one.

Moving down the line in the flow diagram we find the block, marked "gating and risering." Every foundryman is aware of the paramount importance of proper gating and risering. But generally the problem has not been related to heat transfer in the minds of foundrymen. The excellent paper by J. B. Caine[1] presented at the 1948 A.F.S. Convention in Philadelphia shows a promising approach to the proper risering. He shows the importance of relating solidification time of the riser to that of the casting and presents a technique for

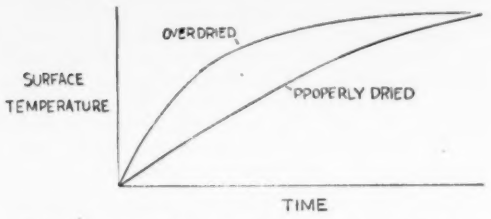

Fig. 10 – Surface temperature of core during drying.

relating the two times. This approach needs to be studied further from the thermal angle. But only a thermal understanding of the solidification procedure will give the desired results.

Similarly the size of the gate and the size of the sink-head are determined thermally. If the gate bridges prior to having transmitted all the liquid metal it obviously has not fulfilled its purpose. But to determine how long it takes to bridge, compared to the solidification time of the casting, is a problem of heat transfer. It can be indicated by the schematic Fig. 11, showing two thermometers, one in the gate, the other in the center of the casting; both thermometers read the same temperature—but the clocks indicate that the casting reaches the temperature later than the gate.

These problems, as well as those of solidification of the casting proper, have been for the past year the object of study by the Heat Transfer Committee.

Electric Analogy Method

Foundrymen may well ask what is the purpose of pointing out the thermal nature of their work if they have no tools for solving them. Undoubtedly an exact solution of the heat problems in the foundry is out of the orbit of normal interest of the average foundryman. But fortunately there are modern tools for the solution of such problems available and A.F.S. has been making use of one of these for the last four years.

It is possible to solve such problems by means of a specialized calculating machine, such as the Heat and Mass Flow Analyzer at Columbia University. For those readers who may be interested the analogy method is here explained somewhat more completely. However, readers may stop here—if they are not interested in how this method works, because it is no more necessary for the foundryman to understand the intricacies of this analyzer than it is necessary for him to understand all the details of a locomotive before he can ride on a train. He uses the latter for transportation—and may use the former for solving his thermal problems. In general terms the Heat and Mass Flow Analyzer may be described as follows.

For reasons not too well understood, nature has provided that heat flow in solid bodies follows the same mathematical laws as the electric current in a special type of circuit. It is possible to devise and calculate this type of circuit in such a manner as to represent a certain physical body and its heat flow problem. By carrying out electrical measurements on such a circuit the answers to the thermal problem become available after a brief but specialized calculation.

As mentioned, the analogy method is based on the identity of the equations governing heat flow in solids and electric flow in non-inductive conductors with evenly distributed capacitance.

One way of ascertaining the analogy is to write the equations for the heat and the electrical systems and compare them. But instead one can simply correlate equivalent magnitudes by the following table:

Thermal System	Electric System
1/conductivity	Resistivity
Thermal capacity	Electric capacity
Temperature	Volt
Rate of Heat Flow	Current

The basic principle of the analogy method is to solve an electric problem, which is so formulated that the results can be interpreted to give the answer to a desired thermal problem. Although it is not the actual procedure, one could imagine that first the mathematics for the thermal problem is written; then finding the mathematics hard to solve, one replaces in the equations the thermal magnitudes, one by one by electric magnitudes, using the above table.

At the end of this process an electric problem is obtained, the mathematical solution of which is just as

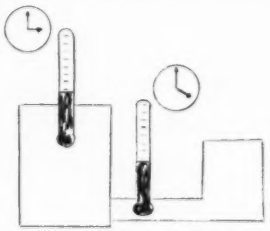

Fig. 11 – Schematic diagram showing relative time for solidification in casting and in gate.

inaccessible as that of the thermal problem. However, the electric problem is subject to experimentation much more readily than the thermal problem would be. Therefore electric experiments are carried out, and then the results are retransformed into heat terms, again using the same table.

It is therefore not important to know the electric properties of the body involved. The electric circuit is developed, using a mathematical key, which consists only in relating the thermal properties of the body to a set of electric units. These do not need to have any physical relationship to the electric characteristics of the body.

The nature of these transformation calculations is such that it is possible to apply a time scale.

A thermal process lasting only a fraction of a second can be represented electrically by an experiment lasting many minutes; and conversely, a slow thermal process, lasting hours or even weeks, can be represented in

an electric experiment lasting only minutes or even seconds.

With this necessarily brief general information about this tool readers are referred to special publications[2] if they wish to familiarize themselves with this technique and to the Heat Transfer Committee reports of the last several years,[3] which reports regularly comprised work with the analyzer.

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Chicago Chapter Presents A.F.S. Memberships to Educators

Starting a new foundry educational project in the Chicago school system, Chicago Chapter Chairman W. D. McMillan, International Harvester Co. (right), presents memberships in the American Foundrymen's Society to (starting left) Howard W. Smith, supervisor of forge, foundry and welding, Chicago Board of Education; Fred H. Dix, Thomas J. Brown and Charles E. Roland, foundry instructors at Lane Technical High School. Also made a member of the Society was L. L. Sutherland, Lane foundry instructor unable to be present. The presentation was made at a meeting June 13 in the office of Lane Principal James H. Smith. Presentation of memberships, sponsored by the Chicago Chapter and instigated by its Educational Committee under the chairmanship of Prof. Roy W. Schroeder, University of Illinois, Navy Pier, Chicago, is expected to occur in other Chicago schools as a prelude to an extensive foundry educational program.

Partial Report On FEF Placements

PLACEMENT in summer and permanent jobs by the Foundry Educational Foundation for this year number 37 graduates and 107 summer students according to incomplete returns as of the end of June. In addition to the seven FEF schools—University of Alabama, Case Institute of Technology, University of Cincinnati, Cornell University, Massachusetts Institute of Technology, Northwestern Technological Institute and University of Wisconsin—the engineering college students placed came largely from Ohio State University, Pennsylvania State College, Purdue University, Michigan State College, Missouri School of Mines, University of Minnesota and Illinois Institute of Technology. Students of several other colleges and universities were also placed.

Recently issued by the Foundation are pamphlets on the University of Alabama and Cornell University. Like the pamphlets issued earlier on Case and Wisconsin, the latest describe the method of admission, courses of study and electives for students planning to enter the foundry industry. Pamphlets on MIT, Cincinnati and Northwestern will be completed later this year by the Foundation.

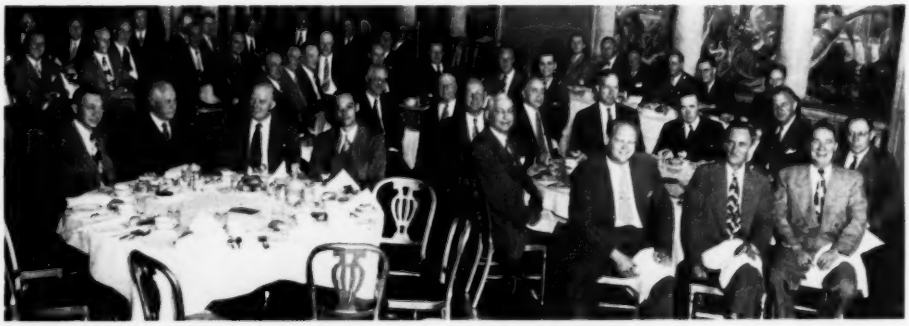
Cope and Drag Club Names Chairman

A YEAR AGO a number of young technical foundrymen formed the Cope and Drag Club to help each other in creating new foundry products and in testing them fully before marketing. Club members also screen and criticize papers members plan to present before A.F.S. meetings and other technical groups.

Chairman of the group for the coming year is Roy W. Bennett, Hydro-Blast Corp., Chicago. Vice-chairman last year, he succeeds O. J. Myers, Werner G. Smith Co., Minneapolis, first chairman of the organization. Other members are: Jos. S. Schumacher, Hill & Griffith Co., Cincinnati; Robert L. Doelman, Miller & Co., Chicago; George P. Antonic, Walter Gerlinger, Inc., Milwaukee; Victor M. Rowell, Velsicol Corp., Chicago; Eugene Conreaux, Illinois Mills Inc., Granite City, Ill.; Leo F. Dennie, Black Products Co., Chicago; Bradley H. Booth, Carpenter Bros., Milwaukee; Clyde A. Sanders, American Colloid Co., Chicago; Frank S. Brewster, Harry W. Dietert Co., Detroit; and Eugene W. Smith, Western Materials Co., Chicago.

The Cope and Drag Club holds quarterly two-day meetings. The first day members hear lectures by one or two of the group or by outside speakers. Extensive discussion and questioning follow. Papers are distributed prior to the meetings so that they may be thoroughly studied. Meetings are held in the laboratories of the various companies represented in the Club membership so that the second day can be devoted to experimental work and testing.

National Foundry Association Holds Regional Meet in Chicago



Attending a Regional Foundry Forum June 1, at the Sheraton Hotel, Chicago, these members of the National Foundry Association heard Stevens H. Hammond, president of the Whiting Corp., Harvey, Ill., discuss current business conditions in the foundry industry. The Meeting also featured a four-man panel on labor relations problems and a talk on the Washington outlook as it affects industry by Association Vice-President L. E. Roark. The Chicago meeting was one of a series sponsored by NFA, others being held in Indianapolis (June 16), Syracuse, (May 19) and Phila. (May 11).

New Foundry Correspondence Course

LATEST ADDITION to the correspondence and extension courses offered by Pennsylvania State College is entitled The Control of Modern Steel Foundry Operations. Covered in 24 assignments, the course is designed to furnish a background in the technology of steel casting operations. Topics covered include: melting processes, with emphasis on close control; sand control, binders and washes, sand reclamation; causes of hot tear defects; origins and effects of gases in steel castings; solidification, gating and risering; cleaning operations; non-destructive inspection; and repair welding. Heat treatment and physical metallurgy are reserved for a second course.

One of a number of courses offered by the Mineral Industries Extension Services of Penn State, the new course on steel foundry operations is the fourth metallurgy course offered by correspondence. Others in the series cover physical ferrous metallurgy and elementary physical metallurgy. Related courses of interest to foundrymen are on fuels and combustion, refractories and ceramic raw materials.

Dedicate Illinois Tech Chemistry, Metallurgical Engineering Buildings

AN ALL-DAY PROGRAM, featuring addresses by prominent educators and industrialists marked the dedication of the Illinois Institute of Technology's new Metallurgical and Chemical Engineering and Chemistry buildings, Chicago, June 17.

Featured speakers and their topics were Linus C. Pauling, president, American Chemical Society—"*New Structural Concepts in Inorganic Chemistry*"; Cyril S. Smith, director of the Institute of Metals of the University of Chicago—"*Microstructure of Metals*"; James B. Austin, director of research, United States Steel Corp.—"*The Blast Furnace Process; An Example of Applied Chemistry and Metallurgy*"; and George Granger Brown, professor of Chemical Engineering, University of Michigan—"*Chemical Engineering at the Crossroads.*"

Other features of the program were an inspection tour of the buildings, and a luncheon and dedication address by James A. Rafferty, vice-president of the Union Carbide & Carbon Corp.

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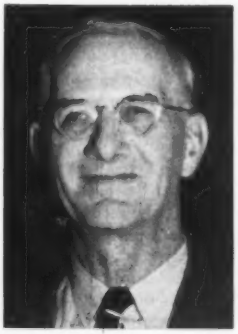

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Questions and Answers — THE ROUND TABLE

Making Cast Iron Pipe

We have been called on to make some special cast iron flanged pipe. What is the standard shrinkage on pipe for length, wall thickness and diameter? Do you have any suggestions for making the patterns and core boxes? The pipe will have to be enamel lined, therefore we must have maximum freedom from gas in the castings.

In connection with your problem of making a total of about 40 Class D flanged pipe, we wonder whether you have considered ordering them from one of the pipe manufacturers. They have standard pattern and core box equipment on hand and generally this is designed to enable them to make various lengths of pipe from one set of equipment. You may be able to purchase the pipe at less than you can produce them when the cost of making special equipment is taken into consideration. The inside surfaces of the pipe must be practically perfect and this should be pointed out to anyone you may ask to make them.

The pipe can be made either on end or in the horizontal position. Since you have not had occasion to make such castings previously, you will no doubt prefer to make them horizontally because this has some advantages from the equipment standpoint. In making a cast iron pipe horizontally, we used 0.125 in. ft shrinkage for the length and 0.1 in. ft for both inside and outside diameter. The latter shrinkage allowances take care of the wall thickness, also.

Inasmuch as the pipe is symmetrical about the center line, a half pattern could be used if you plan to attach to a plate. Otherwise you will have to make two half patterns. Make the flanges somewhat on the heavy side and the overall length on the plus side. This will insure obtaining proper overall length and if necessary the flanges can be back-faced in your machine shop to obtain proper flange thickness. You may wish to make the flange on one end loose or movable so that the overall length can be adjusted in case you find it necessary after having made a sample casting. Provide core prints extending at least 6 in. beyond the flange at each end.

Cores should be made of oil bonded sand and can be made in a half box split in the same manner as the pattern. It may be that you cannot use chaplets because of interference with the enameling process. In this case, heavy arbors must be used in each core half to prevent the core from bowing upward when the iron is poured. The 3 and 4-in. pipe will present the greatest problem in this respect and for them a semicircular or triangular shaped arbor should be used. There should be about ¾ in. of sand between the arbor and the surface of the core. Arbors for the 6 and 8-in. pipe should be in proportion.

Gate so that the iron enters both flanges at the parting line. Gates should be quite large so that the molds fill rapidly. To prevent shrinkage you may wish to gate through a bob type feeder. If you find it necessary to gate into the body of the pipe as well as into the flanges use thin wide gates. Venting is extremely important and can be accomplished by placing a relief sprue at the top of each flange and using a vent wire generously in the cope half of the mold.

W. W. Levi, *Chief Metallurgist*
Lynchburg Foundry Co.
Radford, Va.

Brighter Brass Castings

One of our customers wants certain brass castings supplied with a bright finish. Can you give us suggestions for improving the ordinary sand blasted or tumbled finish?

There are a variety of treatments for producing different colors and finishes on copper-base alloy castings. Simplest of these are the pickling treatments consisting essentially of immersion in acid solutions. A typical procedure is to first pickle the parts in a sulphuric acid solution containing 5 to 10 per cent by volume of 1.83 sp gr acid. Temperature of the solution may be from room temperature up to 150 F. Heating to higher temperatures increases the amount of fuming and corrosion of surrounding structures. Strength of acid, temperature and duration of immersion vary with the alloy being cleaned and the amount of oxide on the surface of the castings.

When pickled in such a solution, brasses may have some residual red stain resulting from undissolved oxides. These stains may be eliminated by immersion in a 4 to 10 per cent solution (by volume) of concentrated sulphuric acid containing 4 to 8 oz per gallon of commercial sodium dichromate. This solution is used at temperatures ranging from 80 to 120 F.

To achieve a bright lustrous finish, first pickle in the sulphuric acid solution, then dip in the following solutions:

Dip A: 40 per cent nitric acid, sp gr 1.40; 30 per cent sulphuric acid, sp gr 1.83; 0.5 per cent hydrochloric acid, sp gr 1.16; and 29.5 per cent water.

Dip B: 25 per cent nitric acid, sp gr 1.40; 60 per

cent sulphuric acid, sp gr 1.83; 0.2 per cent hydrochloric acid, sp gr 1.16; and the remainder water.

Quantities are all by volume and the solutions are used at room temperature. Parts are immersed in Dip A, rinsed in cold running water, immersed in Dip B and rinsed immediately in cold running water, followed by rinsing in a sodium cyanide solution containing 2 to 4 oz of sodium cyanide per gallon of water to remove all acid stains. The castings are finished by quickly rinsing in water and drying.

DANGER! *It is important that all of the acid be completely rinsed off the part before dipping it into the cyanide solution. Otherwise deadly hydrogen cyanide gas will form.*

Pickling baths and cyanide baths should be equipped with forced draft exhaust hoods.

Gray Irons — Now And In 1900

What are the average properties of the gray iron produced today as compared with 1900? I am especially interested in values for strength, ductility and hardness.

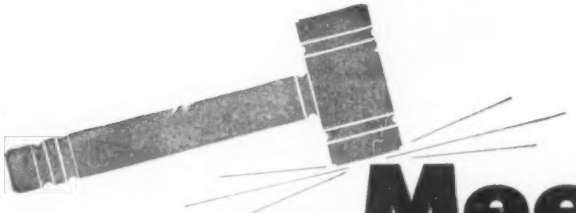
Ultimate tensile strength of cast irons at the beginning of the century was in the neighborhood of 15,000 to 20,000 psi whereas today specific irons are made for minimum tensile strengths ranging from 20,000 to 60,000 psi as provided for in specification A48-46 of the American Society for Testing Materials. Some foundries regularly produce irons of well over 60,000 psi tensile strength and values over 100,000 have been reported.

The ductility of gray iron is seldom determined since design engineers do not normally utilize gray iron in an application requiring high ductility. When first stressed, cast iron shows a distinct permanent deformation of a few tenths of a percent. Repetition of the same stress gives very little more deformation and, after 5 to 10 loadings, the metal behaves as a perfectly elastic material according to the latest edition of the A.F.S. CAST METALS HANDBOOK (page 370). An iron in the higher tensile strength ranges shows no further plastic deformation after many hundreds of repeated loadings at 80 per cent of the breaking load. However, if the material which has become completely elastic at one loading is subjected to a higher loading, it behaves as virgin material between the first and second load. The metal will take an additional "set" if the temperature is raised.

Extensive information on ductility and elasticity of white and gray irons is given in an article by that name (AMERICAN FOUNDRYMAN, August, 1946, pages 47-59) and prepared by R. A .Flinn and H. J. Chapin of American Brake Shoe Co., Mahwah, N. J. This paper indicates that as the matrix changes from pearlite to austenite, the plastic elongation of gray irons changes from 0.5 to 3.0 per cent. For white and mottled irons the figures are 0.00 to 0.05.

Hardness of gray iron can be controlled to meet specific requirements. In comparison with the irons of half a century ago, it can be said that hardness can now be controlled well whereas in years gone by customers took quite a chance on hardness.

Nodular graphite cast iron—subject of considerable speculation and study by foundrymen today—cannot be considered a gray cast iron in the currently accepted sense of the term. Tensile strengths ranging from 75,000 to over 100,000 psi, as cast and 60,000 to 80,000 psi, annealed, and elongations ranging up to 13 per cent, as cast, and up to 22 per cent, annealed, have been reported.



Chapter Meetings

JULY 23
TOLEDO
El Rancho, on Route 20, 8 miles east of Toledo
ANNUAL PICNIC

JULY 25
TWIN CITY
Midland Hills Golf Club, St. Paul
GOLF PARTY

AUGUST 12
CENTRAL OHIO
Brookside Country Club, Columbus
ANNUAL OUTING

AUGUST 13
CHICAGO
Lincolnshire Country Club, Crete
STAG PARTY AND GOLF OUTING

AUGUST 20
WESTERN MICHIGAN
Pontaluna Golf Club, Muskegon
ANNUAL PICNIC

AUGUST 27
ONTARIO
Estate of Ralph Barnes, Waterdown, Ont.
ANNUAL PICNIC

SEPTEMBER 4
BIRMINGHAM DISTRICT
Roebuck Country Club, Birmingham
ANNUAL OUTING

SEPTEMBER 10
CANTON DISTRICT
Alliance Country Club, Alliance, Ohio
ANNUAL PICNIC

SEPTEMBER 17
ROCHESTER
Barnard's Exempt Firemen's Association, Pomona Drive at Dewey Ave., Rochester
ANNUAL PICNIC

WHO'S WHO

Gosta Vennerholm

Gosta Vennerholm (*"Symposium on Nodular Graphite Cast Iron,"* Page 32) is this year's A.F.S. Wm. H. McFadden Gold Medalist . . . Born and educated in Sweden, Mr. Vennerholm came to the United States in 1924 after a brief period spent teaching metallurgy and engineering in Germany . . . Armed with a letter of introduction to the late Henry Ford from Swedish Explorer Sven Hedin, Mr. Vennerholm went to work in Ford Motor Co.'s Physical Laboratory . . . During his 25 years with Ford, Mr. Vennerholm was co-discoverer of many ferrous alloys and casting methods . . . His career with Ford has included establishing apprentice courses in metallurgy and physics, organization and supervision of the Ford Experimental Foundry, modernization of the company's foundry at Dagenham, England, and the development of armor plates for tanks during World War II . . . A member of the Program and Papers Committee of the A.F.S. Malleable Steel Division, Mr. Vennerholm has been a frequent speaker at Society meetings.

D. J. Reese

Donald J. Reese (*"Symposium on Nodular Graphite Cast Iron,"* Page 32) is head of the International Nickel Co.'s Development and Research Division . . . Active for many years in A.F.S., Mr. Reese is a member of the Gray Iron Division's Advisory Group and has been a frequent speaker at chapter, regional and national meetings of the Society . . . Mr. Reese was employed for several years as a chemist and bessemer furnace operator in Midwestern foundries prior to attending the University of Michigan, where he received a degree in Chemical Engineering in 1925 . . . Following graduation, he joined the Whiting Corp. as foundry engineer and superintendent, and later as metallurgist after a two-year period as metallurgist with the Grindle Fuel Equipment Co. . . . Joining International Nickel in 1942 as chief industrial specialist for the company's metallurgical and specifications section, Mr. Reese has since headed several of the company's manufacturing divisions . . . As president of the Chicago Foundrymen's Club in 1933, he was instrumental in inducing that organization to become the first chapter of A.F.S.

C. K. Donoho

C. K. Donoho (*"Symposium on Nodular Graphite Cast Iron,"* Page 32) has been with the American Cast Iron Pipe Co. since receiving his M.S. from Vanderbilt University in 1931 . . . He is now chief metallurgist there . . . Widely known as a writer and speaker on foundry metallurgical problems, Mr. Donoho has been a frequent contributor to the technical press and has spoken before meetings of A.F.S., and many other technical groups.

R. G. McElwee

R. G. McElwee (*"Symposium on Nodular Graphite Cast Iron,"* Page 32) is an A.F.S. John A. Penton Gold Medalist (1948), and is chairman of the A.F.S. Gray Iron Division and its Cupola Research Committee . . . Mr. McElwee began his foundry career 32 years ago as chief inspector for the Muncie Foundry & Machine Co., Muncie, Ind. . . . He has since been associated with General Motors Truck Co., American Car & Foundry Co., Whitehead & Sales Co., and the Ecorse, Mich., Foundry Co., prior to joining the Vanadium Corp. of America, where he is today manager of the company's iron foundry in Detroit.

Mario Olivo

Mario Olivo, author of *"Biringuccio—foundryman of 1500,"* Page 28, is president of the Italian Foundrymen's Society, and of the Foundry Equipment Manufacturers of Italy, and a member of the Board of Directors of the Italian Metallurgical Association . . . Owner of the Impianto Fonderie Olivo in Milan, Mr. Olivo has won many awards for his developments in foundry practice and is the donor of the Italian Foundrymen's Society's Annual Olivo Award for foundry achievement . . . He is author of *Practical Guide to Foundry Work*, widely used in Europe, and of several technical papers presented before meetings of the International Foundry Congress before the war . . . Two of his more recent books, *Fonderia*, and *Moderna Fonderia*, have sold more than 15,000 copies.

John Howe Hall

John Howe Hall, author of *"Modern Foundry Methods,"* Page 42, was this year's Charles Edgar Hoyt Annual Lecturer at the 53rd A.F.S. Convention in St. Louis . . . The first recipient of the A.F.S. John H. Whiting Gold Medal (1924), Mr. Hall has pioneered many new developments in steel metallurgy . . . Holder of bachelor's and master's degrees from Harvard University, Mr. Hall was employed in executive metallurgical capacities in several Eastern foundries prior to establishing his own business as a consulting metallurgist in Swarthmore, Pa. . . . He is active in several technical societies and is widely known as a speaker.

M. O. Booth

Myron O. Booth, author of *"Quality Control Review—Summarize Test Procedures for Malleable Foundrymen,"* Page 56, is plant manager of the Saginaw Malleable Plant of General Motors Corp.'s Central Foundry Division, Saginaw, Mich. . . . A graduate of the Arthur Hill Trade School, Saginaw, in 1927, Mr. Booth began work as a draftsman with the Michigan Bell Telephone Co., Saginaw, that same year as a draftsman . . . Leaving there the following year, Mr. Booth became a physicist's helper at Saginaw Malleable, and was subsequently appointed foreman in 1932, general foreman in 1937, superintendent in 1939, and to his present position as plant manager in 1946. Mr. Booth was one of five speakers chosen for the Annual Lecture Series presented at the 1948 A.F.S. Convention.

A. J. Smith

Austen J. Smith, author of *"Research Will Advance Brass and Bronze Practice,"* Page 44, is the author of this year's A.F.S. Exchange Paper to the Institute of British Foundrymen . . . Holder of a B.S., M.S. and Ph. D. from Yale University, Dr. Smith is now an associate professor of Metallurgical Engineering at Michigan State College, and prior to that, was assistant director of research for the Lunkenheimer Co., Cincinnati. A member of the A.F.S. Brass and Bronze Research Committee, Dr. Smith was vice-chairman of the A.F.S. Cincinnati District Chapter in 1948. He has also served as a member of the National Nominating Committee of A.S.M. (1946) and as chairman of the organization's Cincinnati Chapter (1943-44). He has presented several technical papers before engineering society meetings.

A. D. Barczak

Alexander D. Barczak *"Stop Metal Losses and Watch Costs Go Down,"* Page 50, is plant manager of Superior Foundry, Inc., Cleveland . . . A graduate of the University of Detroit, he began his foundry career with the Chevrolet Gray Iron foundry in his home town, Saginaw, Mich., in 1930, and was supervisor there until 1942, when he joined the Bardes Forge & Foundry Co., Cincinnati, as vice-president . . . Mr. Barczak served as vice-chairman, chairman and a member of the Board of Directors of the A.F.S. Cincinnati District Chapter in 1947-8 . . . He has spoken before chapter and national meetings of the Society.

Victor Paschkis

Victor Paschkis, author of *"Heat Transfer—A Foundryman's Tool,"* Page 59, is head of Columbia University's Heat and Mass Flow Analyzer Laboratory . . . A native of Austria, he received a D. Sc. degree from the University of Vienna and for several years was employed with various European firms and as consulting engineer . . . Coming to the United States in 1938, Dr. Paschkis joined the A.F. Holden Co., New Haven, Conn., as head of its Furnace Department, and a year later became research and design engineer for the Ajax Electric Co., Philadelphia . . . He has been with Columbia University since 1940 . . . Dr Paschkis has written extensively on the subjects of heat flow and transfer for technical publications here and abroad.

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DETROIT CHAPTER *Secretary,* J. N. Phelps, Vanadium Corp. of America, 2440 Book Tower, Detroit

EASTERN CANADA CHAPTER *Secretary,* J. G. Hunt, Dominion Engineering Works, Ltd., P. O. Box 220, Montreal, Que., Can.

EASTERN NEW YORK CHAPTER *Secretary-Treasurer,* Leigh M. Townley, Adirondack Foundries & Steel Co., Watervliet, N. Y.

METROPOLITAN CHAPTER *Secretary,* J. F. Bauer, Hickman, Williams & Co., 70 Pine St., New York

MEXICO CITY CHAPTER *Secretary,* N. S. Covacevich, Apartado 1030, Mexico, D. F., Mexico

MICHIANA CHAPTER *Secretary-Treasurer,* J. Paul Jordan, Dodge Mfg. Corp., Mishawaka, Ind.

MO-KAN CHAPTER *Secretary,* C. W. Myers, Jr., Morton-Myers Co., P. O. Box 1039, Kansas City, Mo.

NORTHEASTERN OHIO CHAPTER *Secretary,* A. J. Harlan, Hickman, Williams & Co., 1154 Union Commerce Bldg., Cleveland, O.

NORTHERN CALIFORNIA CHAPTER *Secretary,* Charles R. Marshall, Industrial Foundry Supply Co., 1434 Howard St., San Francisco

NORTHERN ILLINOIS-SOUTHERN WISCONSIN *Secretary,* Carl L. Dahlquist, 120 So. Highland, Rockford, Ill.

NORTHWESTERN PENNSYLVANIA CHAPTER *Secretary,* Earl Strick, Erie Malleable Iron Co., Erie, Pa.

ONTARIO CHAPTER *Secretary-Treasurer,* G. L. White, Westman Publications, Ltd., 137 Wellington St. W., Toronto, Ont., Canada

OREGON CHAPTER *Secretary-Treasurer,* Harry K. McAllister, 627 S. E. 71st Ave., Portland, Ore.

PHILADELPHIA CHAPTER *Secretary-Treasurer,* W. B. Coleman, W. B. Coleman & Co., 9th & Rising Sun Ave., Philadelphia

QUAD CITY CHAPTER *Secretary-Treasurer,* C. R. Marthens, Marthens Co., 3091½ 16th St., Moline, Ill.

ROCHESTER CHAPTER *Secretary-Treasurer,* Leon C. Kimpal, Rochester Gas & Electric Corp., 89 East Ave., Rochester, N. Y.

SAGINAW VALLEY CHAPTER *Secretary-Treasurer,* Raymond H. Klawuhn, General Foundry & Mfg. Co., P. O. Box 119, Flint, Mich.

ST. LOUIS DISTRICT CHAPTER *Secretary,* P. E. Retzlaff, Busch-Sulzer Bros.-Diesel Engine Co., Div. Nordberg Mfg. Co., 5300 S. Second St., St. Louis

SOUTHERN CALIFORNIA CHAPTER *Secretary,* Harold G. Pagenkopp, Angelus Pattern Works, 2084 Belgrave Ave., Huntington Pk., California

TENNESSEE CHAPTER *Secretary-Treasurer,* Herman Bohr, Jr., Robbins & Bohr, Chattanooga Bank, Chattanooga, Tenn.

TEXAS CHAPTER *Secretary,* P. B. Croom, 5210 Canal, Houston, Texas

TIMBERLINE CHAPTER *Secretary,* James Schmuck, Rotary Steel Castings Co., 1425–5th St., Denver, Colorado

TOLEDO CHAPTER *Secretary-Treasurer,* R. C. Van Hellen, Unitcast Corp., Box 8, Station E, Toledo, Ohio

TRI-STATE CHAPTER *Secretary,* D. A. Mitchell, Progressive Brass Co., 1702 East 6th, Tulsa, Okla.

TWIN-CITY CHAPTER *Secretary-Treasurer,* Lillian K. Polzin, Minneapolis Chamber of Commerce, 1750 Hennepin at Groveland Terrace, Minneapolis

WASHINGTON CHAPTER *Secretary,* F. R. Young, E. A. Wilcox Co., 517 Arctic Bldg., Seattle 4, Wash.

WESTERN MICHIGAN CHAPTER *Secretary,* Ross Shaffer, Lake Foundry & Machine Co., First & Water Sts., Muskegon, Mich.

WESTERN NEW YORK CHAPTER *Secretary,* R. E. Walsh, Hickman, Williams & Co., 32 Eastwood Place, Buffalo, N. Y.

WISCONSIN CHAPTER *Secretary,* G. E. Tisdale, Zenith Foundry Co., 1501 So. 83rd St., West Allis, Wis.

STUDENT CHAPTERS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY *Secretary-Treasurer,* Robert N. Randall

UNIVERSITY OF ILLINOIS *Secretary,* Eugene Keith Van Ness

UNIVERSITY OF MINNESOTA

MISSOURI SCHOOL OF MINES *Secretary,* Martin L. Slawsky

OHIO STATE UNIVERSITY *Secretary-Treasurer,* Arthur Stoner

OREGON STATE COLLEGE *Secretary,* Leonard M. Preston

TEXAS A & M COLLEGE *Secretary,* Victor C. Henkel

NEW COMPANY MEMBERS

Oil Well Supply Co., Witte Engine Wks. Div., Kansas City, Mo.—Harry W. Adams, Asst. to Wks. Mgr. (Mo-Kan Chapter).

CANTON DISTRICT CHAPTER

Harold C. Templeton, Met., Babcock & Wilcox Co., Barberton, Ohio.

CENTRAL INDIANA CHAPTER

T. H. Hardy, Vice Pres., Hougland & Hardy, Evansville, Ind.

CENTRAL OHIO CHAPTER

Jose Acebo, Sand Tester, Ohio Malleable Iron Co., Columbus, Ohio.
O. De Pietro, Annealing Rm. Fmn., Ohio Malleable Iron Co., Columbus, Ohio.
Thomas S. Dole, Asst. Maint. Engr., Dayton Malleable Iron Co., Ironton, Ohio.
John Robert Heid, Master Mech., Ohio Malleable Iron Co., Columbus, Ohio.
Daniel D. Richards, Fmn., Ohio Malleable Iron Co., Columbus, Ohio.
Owen A. Shafer, Melting Supv., Ohio Malleable Iron Co., Columbus, Ohio.
Carl Tegge, Fmn., Ohio Malleable Iron Co., Columbus, Ohio.

CHICAGO CHAPTER

Paul R. Gouwens, Res. Engr., Fahralloy Co., Harvey, Ill.
L. G. Jessup, Sls. Eng., Western Metals Co., Chicago.
Charles H. Jones, Sls. Engr., Steel Sales Corp., Chicago.
T. W. MacLean, Sls. Repr., Western Metal Co., Chicago.
J. J. O'Sullivan, Pres., Metal Parts & Equipment Co., Chicago.
Frank Soderstrom, Fdy. Supt., Continental Fdy. & Mach. Co., East Chicago, Ind.
E. P. Weaver, American Colloid Co., Chicago.

CINCINNATI CHAPTER

Donald L. Crews, Asst. Prof., University of Cincinnati, Cincinnati.
Robert Maurice Goldhoff, Student, University of Cincinnati, Cincinnati.

DETROIT CHAPTER

Fred M. Baker, Jr., Fdy. Asst., University of Michigan, Ann Arbor, Mich.
Spencer Harrison Bush, Student, University of Michigan, Ann Arbor, Mich.
Floyd R. Gladwin, Ind. Engr. Fdries., Ford Motor Co., Dearborn, Mich.
Edward J. Moore, Sls. Engr., Claude B. Schneible Co., Detroit, Mich.
Kenneth F. Packer, Student, University of Michigan, Ann Arbor, Mich.
Willard W. Rice, Slsmn., A. P. Green Fire Brick Co. of Mich., Detroit.
Beatrice Wilcox, Lab. Tech., Dostal Per-Mold Fdy. Co., Pontiac, Mich.

EASTERN NEW YORK CHAPTER

John V. McCarthy, Sls. Repr., Federated Metals Div., American Smelting & Refining Co., Stratford, N. Y.

METROPOLITAN CHAPTER

Leonard S. Croan, Met., Worthington Pump & Machine Corp., Harrison, N. J.
W. A. King, Sales Engr., American Cyanamid Co., New York.
Paul J. Scherbner, Fdy. Met., Sperry Gyroscope Co., Brooklyn, N. Y.

MO-KAN CHAPTER

Oil Well Supply Co., Witte Engine Wks. Div., Kansas City, Mo. (Harry W. Adams, Asst. to Wks. Mgr.).
L. A. Jarrett, Plt. Mgr., The Locomotive Finished Material Co., St. Joseph, Mo.
William Henry Maness, Core Room, Witte Engine Works, Kansas City, Mo.
Fred Monasmith, C/R Fmn., Blue Valley Foundry, Kansas City, Mo.

NORTHEASTERN CHAPTER

Jack E. Eidam, Layout Man, National Mall. & Steel Cstgs. Co., Cleveland.
Joseph G. Seifert, Appr., Pattn. Maker, Cleveland Standard Pattern Wks., Cleveland.

ONTARIO CHAPTER

Andrew Walter Auchincloss, Field Engr., Whiting Corp. (Canada), Toronto, Ont., Canada.
Carl N. Hill, Fdy. Fmn., Canadian General Elec. Co., Peterboro, Ont., Canada.

PHILADELPHIA CHAPTER

Thomas N. Peck, Dir. Alum. Alloy Div., Vanadium Corp. of America, Chester, Pa.
William E. Thomas, Met., General Machine Co., Emmaus, Pa.
Donald E. Wyman, Sls. Engr., Alum. Alloy Div., Vanadium Corp. of Amer., Chester, Pa.

QUAD CITY CHAPTER

Charles R. Bloome, Asst. Met., Union Malleable Iron Works, of Deere & Co., E. Moline, Ill.
Donald W. Grundstrom, Fmn., Labor Dept., Union Malleable Iron Works, of Deere & Co., E. Moline, Ill.
James E. Murphy, Molder Fmn., Union Malleable Iron Works, of Deere & Co., E. Moline, Ill.
Earl L. Smith, Fmn., Tool Rmn. & Tool Crib, Union Malleable Iron Works, of Deere & Co., E. Moline, Ill.
DeMar C. Taylor, Molder Fmn., Union Malleable Iron Works, of Deere & Co., E. Moline, Ill.

SAGINAW VALLEY CHAPTER

Lloyd Adsit, Fmn., Cleaning Dept., Chevrolet Grey Iron Fdy. Div., G.M.C., Saginaw, Mich.
Arthur F. Arnold, Supv., Auditing, Chevrolet Grey Iron Fdy. Div., G.M.C., Saginaw, Mich.
Neil Brown, Supv. of Time & Const., Chevrolet Grey Iron Fdy. Div., G.M.C., Saginaw, Mich.
Angus B. Chamberlin, Sls. Engr., Edall Corp., Detroit.
Leo A. Hagerl, Fmn., Cleaning Dept., Chevrolet Grey Iron Fdy. Div., G.M.C., Saginaw, Mich.
Frank A. Morrison, Slsmn., Jennison Hardware Co., Bay City, Mich.
Dorsey N. Nellett, Gen. Fmn., Cleaning Dept., Chevrolet Grey Iron Fdy. Div., G.M.C., Saginaw, Mich.
George R. Sandenburgh, Dow Chemical Co., Ann Arbor, Mich.

ST. LOUIS DISTRICT CHAPTER

Charles D. Gray, Fdy. Supt., Layne & Bowler, Memphis, Tenn.
Werner C. Jarchow, Mech. Supt., General Steel Cast. Corp., St. Louis.
Robert C. Kane, Slsmn., Midvale Mining & Mfg. Co., St. Louis.
Albert M. Kraft, Repr., Master Pneumatic Tool Co., Webster Groves, Mo.
Jack L. Mueller, Slsmn., United States Graphite Co., Kirkwood, Mo.
Lester Segar, General Steel Castings Corp., St. Louis.

SOUTHERN CALIFORNIA CHAPTER

William F. Comiskey, Pattn. Maker, Compton Foundry, Compton, Calif.
Allen S. Kridler, Molder, Compton Foundry, Compton, Calif.

TIMBERLINE CHAPTER

J. N. Carter, Wks. Mgr., American Foundry & Machine Co., Salt Lake City, Utah.

TOLEDO CHAPTER

Walter E. Drager, Plt. Engr., Bunting Brass & Bronze Co., Toledo, Ohio.
Charles E. Eggenschwiler, Asst. Chief Met., Bunting Brass & Bronze Co., Toledo, Ohio.

TRI-STATE CHAPTER

H. C. McFerrin, Treasurer, Pressure Cast Prod. Corp., Coffeyville, Kan.

TWIN CITY CHAPTER

S. L. Cameron, Jr., Vice Pres., Valley Iron Works, St. Paul, Minn.
J. David Johnson, Met., Werner G. Smith Co., Minneapolis, Minn.

WASHINGTON CHAPTER

Robert H. Raymond, Sls. Engr., Eagle Metals Co., Seattle, Wash.

STUDENT CHAPTERS

MISSOURI SCHOOL OF MINES

Edward Patrick Lasko

OHIO STATE UNIVERSITY

David Milton Williams

TEXAS A & M
Glenn William Peterson

UNIVERSITY OF ILLINOIS
John Oliver Aarvold, Jr.
David E. Cash
Charles F. Fails
Robert Eugene Lawrence
Charles G. Moore, Jr.
Fred W. Rohr

OUTSIDE OF CHAPTER
George W. Altman, Eng. & Met., National Radiator Co., Johnstown, Pa.
William J. Francis, Jr., Supt., Draper Corp., Framingham, Mass.
Paul J. Kaveny, Wks. Mgr., Herman Pneumatic Machine Co., Zelienople, Pa.

Australia
Alan G. Tomlinson, Tech. Dir., Tomlinson Steel Pty. Ltd., Perth, Western Australia.

England
J. W. Hallsworth, Thos. Firth & John Brown Ltd., Castings Div., Scunthorpe, Lincs., England.
John Vickers, Foundry Consultant, Darlington-Co., Durham, England.

France
Pierre Prette, Ingenieur, Atelier de Construction, Puteaux, France.

India
Shantilal J. Jain, Student Trainee, Gov. of Madyabharat, India, Madyabhara, India.

MALLEABLE FOUNDERS HOLD ANNUAL MEETING

MALLEABLE FOUNDRYMEN from the United States and Canada gathered June 16 and 17 at Hot Springs, Va., for the annual meeting of the Malleable Founders' Society. Business sessions included reports of the various Society officers and committees and the annual banquet the evening of the first day when the McCrea Award was presented to Anthony Haswell, Dayton Malleable Iron Co., Dayton, Ohio. Cal C. Chambers, Texas Foundries, Inc., Lufkin, Tex., made the presentation.

Malleable Founders' Society officers for the coming year, announced at the annual banquet, are: Jas. H. Smith, General Motors Corp., Saginaw, Mich., president; Ralph T. Rycroft, Kencroft Malleable Co., Buffalo, N. Y., vice-president; and D. V. Walker, Eastern Malleable Iron Co., Cleveland, treasurer. Lowell D. Ryan will continue as managing director and secretary with James H. Lansing as technical director.

The annual meeting opened with a report from the retiring president, Collins L. Carter, Albion Malleable Iron Co., Albion, Mich.

Following reports on the activities of the various MFS committees, a report on the Society's nodular iron research project at Southern Research Institute, Birmingham, Ala., was presented. Describing the work were: Leon J. Wise, Chicago Malleable Castings Co., Chicago, chairman of the steering committee; James H. Lansing; and W. H. Austin, Jr., Southern Research.

W. H. Cantelon, Auto Specialties Mfg. Co. (Canada) Ltd., Windsor, Ont., president of the Canadian Malleable Institute whose members joined the Malleable Founders' Society this year, described the activities of his organization and the relationship between Canadian and United States malleable foundries.

President-Elect Jas. H. Smith opened the second day's session by outlining the Society's activities for the coming year, explaining that they would be built around the work of the organization's 10 committees. Chairmen named to head the committees during the coming year are: Ralph N. Cole, Canton Malleable Iron Co., Canton, Ohio, cost accounting; Thomas T. Lloyd, Albion Malleable Iron Co., Albion, Mich., plant operations; C. M. Lewis, Badger Malleable & Mfg. Co., South Milwaukee, Wis., programs; George E. Bean, Eastern Malleable Iron Co., Wilmington, Del., research and product improvement; William A. Kennedy, Columbia Malleable Castings Corp., Columbia, Pa., technical council; W. J. MacNeill, Dayton Malleable Iron Co., publicity and market development; Richard W. Crannell, Lehigh Foundries, Inc., Easton, Pa., education; Arthur F. Jackson, Lake City Malleable Co., Ashtabula, Ohio, government affairs; Frank E. Clark, Wm. E. Pratt Mfg. Co., Joliet, Ill., membership; and W. H. Moriarity, National Malleable & Steel Castings Co., Cleveland, finance.

Officers and directors of the Malleable Founders' Society. Front row, left to right: Collins L. Carter, Albion Malleable Iron Co., Albion, Mich., retiring president; Ralph T. Rycroft, Kencroft Malleable Co., Buffalo, N. Y., vice-president; James H. Smith, General Motors Corp., Saginaw, Mich., president; John T. Llewellyn, II, Chicago Malleable Castings Co., Chicago. Second row: W. Scott Roby, Peoria Malleable Castings Co., Peoria, Ill.; John A. Wagner, Wagner Malleable Iron Co., Decatur, Ill.; Henry P. Blumenauer, Sr., Albany Castings Co., Voorheesville, N. Y.; Frank D. Brisse, Laconia Malleable Iron Co., Laconia, N. H. Third row: Arthur F. Jackson, Lake City Malleable Co., Cleveland; James H. Lansing, MFS technical and research director; Lowell D. Ryan, MFS managing director and secretary; Frank O. Parker, Dayton Malleable Iron Co., Dayton, Ohio; Charles A. Gutenkunst, Jr., Milwaukee Malleable & Grey Iron Works, Milwaukee.

Personalities

David G. Anderson, formerly consulting foundry engineer for the National Foundry Association, Chicago, is now conducting his own consulting service to the foundry industry, operating from his Clarendon Hills, Ill., office. Mr. Anderson for

D. G. Anderson

many years held engineering and operational supervisory foundry positions prior to serving the Western Electric Co., Chicago, as foundry engineer for 21 years.

Harry R. Dahlberg, assistant professor of Engineering at Oregon State College, where he was instrumental in the formation of the A.F.S. Oregon State College Student Chapter and served as its Faculty Adviser since its inception last year, has joined the Twin City Testing and Engineering Laboratory, St. Paul, as metallurgical engineer.

Clyde Williams, director of the Battelle Memorial Institute, Columbus, Ohio, received the honorary degree of Doctor of Engineering at recent commencement ceremonies of the Michigan College of Mining and Technology, Houghton, Mich., for his "accomplishments in scientific research and administration and personal contributions to victory" in World War II. Dr. Williams has been similarly honored by the University of Utah and the Case Institute of Technology.

H. L. Smalley, assistant to the vice-president of the Harbison-Walker Refractories Co., Pittsburgh, has been made assistant to the president. Mr. Smalley, who has been with Harbison-Walker since 1922, was at one time Chicago District sales manager. He will make his headquarters in Pittsburgh.

George M. Baumann has been appointed purchasing agent and assistant to the plant manager of the Whiting, Ind., plant of the Federated Metals Division of the American Smelting & Refining Co. Mr. Baumann, a metallurgical engineer and graduate of Columbia University, has for the last three years been assistant to the general manager of Scrap Purchases at the company's headquarters in New York.

Dr. W. R. Morgan, formerly research professor of Ceramic Engineering at the University of Illinois, has been appointed director of production and engineering for the new Vitrified Division plant of the Peninsular Grinding Wheel Co., Detroit.

W. R. Morgan

Formerly director of research at Bay State Abrasive Products, Dr. Morgan also served as associate professor of Ceramic Engineering at Rutgers University. Simultaneously, it was announced that **R. G. Caulley** has been appointed general sales manager for Peninsular. Mr. Caulley was formerly assistant sales manager for Republic Steel Corp., director of purchases for Fruehauf Trailer Co., and at one time operated his own steel warehouse in Florida, prior to joining Peninsular.

Peter P. Ruppe, formerly chief engineer for Hapman Conveyors, Inc., Detroit, has been made general manager of the company. A graduate of Michigan State College, Mr. Ruppe was formerly connected with the U. S. Rubber Co., and the Briggs Mfg. Co.

Mathieson Chemical Corp., New York, announces changes in its Sales department executive staff as a result of the retirement of **E. E. Routh,** vice-president and director of sales. **D. W. Drummond** has been named vice-president and director of Industrial Chemical Sales, and **S. L. Nevins** has been named vice-president and director of Agricultural Chemical Sales. Other appointments are as follows: **J. O. Logan** becomes sales manager, Industrial Chemicals; **R. J. Quinn,** assistant sales manager, Industrial Chemicals; **L. P. Thomas,** Southwestern sales manager, Industrial Chemicals; and **J. S. Whittington,** sales manager, Industrial Chemicals.

Harold J. Roast, A.F.S. Honorary Life Member who retired from business two years ago to write technical articles, has reestablished his consulting practice in metallurgy and chemistry. Mr. Roast will act as consultant in solving non-ferrous metallurgy problems; in organizing new foundries; in advising foundry executives as to plant layout, personnel and production; and in assisting executives in the operation of foundries. Mr. Roast has had more than 30 years' experience in the foundry industry and for many years was technical vice-president of Canada's largest bronze foundry company. He has announced that he will act as consultant to foundries anywhere within the United States and Canada.

Ira E. Cruse, formerly core room superintendent for the Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich., for seven years, recently joined Sonith Indus-

Ira E. Cruse

try, Indianapolis, as foundry and core room superintendent. Mr. Cruse, who served his apprenticeship in 1918, has held supervisory core room positions in several foundries in the Midwest.

George N. Shepherd, formerly general superintendent of the Duncan Foundry & Machine Co., Alton, Ill., recently joined

the Sterling Steel Casting Co., East St. Louis, Ill., where he will organize and head a Standard Practices Department. Mr. Shepherd, who is the newly-elected chairman of the A.F.S. St. Louis District Chapter, entered the foundry industry in 1919 with the American Steel Foundries, Granite City, Ill., and was made general foreman of that company's Alliance, Ohio, plant in 1937. He resigned in 1944 to become superintendent of the Government-owned plant operated by the Key Co., at East St. Louis, Ill., during the war.

J. Henry Bruhn, foundry superintendent for the Eastern Malleable Iron Co., Wilmington, Del., has been promoted to

J. H. Bruhn

the position of assistant plant superintendent. His duties will include supervision of all foundry operations for Eastern. Mr. Bruhn began his career as an apprentice molder with the Illinois Malleable Iron Co., Chicago, in 1910, and was employed by American Steel Foundries, East Chicago, Ind., prior to joining Eastern Malleable Iron Co. in 1947.

Several new appointments in executive personnel announced by the American Brake Shoe Co. are: **Curtis C. Gary,** for-

C. C. Gary

merly assistant to the vice-president in charge of Division Sales, to be assistant to the president of the Brake Shoe & Castings Division; **John F. Ducey, Jr.,** who has been with Brake Shoe since 1936, to be New York District Sales Manager; **Sam R. Watkins,** who has been with the Company since 1939, to be Cleveland District Manager; **Donald C. Sheldon,** a member of the company's Treasury Department, to be assistant treasurer; and **Kenneth A. Anderson,** also of the Brake Shoe Treasury Department, to be assistant secretary. **Gilfry Ward** has been made vice-president in charge of sales of the American Manganese Steel Division and will make his headquarters in Chicago Heights, Ill. It was also announced that **James R. Shepard** has been appointed Western District Works manager, and **Thomas J. Wood** Eastern District Works manager of the company's Brake Shoe & Castings Division. Mr. Shepard will be located in Chicago and Mr. Wood in New York.

OBITUARIES

Edward B. Butterfield, foundry superintendent, Rochester Castings Corp., Rochester, N. Y., died April 4. Mr. Butterfield was responsible for organizing the company's foundry and training its personnel during his many years as a foundry executive with Rochester Castings. Prior to joining Rochester Castings, Mr. Butterfield was for 17 years head of the Aluminum and Brass Division of the General Railway Signal Co. Mr. Butterfield served with the Army in France during World War I.

James B. Thorpe, a director, vice-president, secretary and treasurer of the Climax Molybdenum Co., New York, died January 29. Mr. Thorpe had been associated with Climax Molybdenum since 1926, first as a metallurgical engineer and subsequently as vice-president, director, secretary and treasurer. He was also a director, secretary and treasurer of the company's Michigan and Pennsylvania subsidiaries.

Alexis Caswell, retired secretary and business manager of the Manufacturers' Association of Minneapolis and from 1943 to 1947 secretary of the A.F.S. Twin City Chapter, died at his home in Minneapolis June 3. Mr. Caswell had devoted 40 years to civic work and the industrial development of Minneapolis. While affiliated with the Manufacturers' Association of Minneapolis, Mr. Caswell was instrumental in sponsoring the A.F.S. Twin City Chapter, the Northwest Section of the American Welding Society; the North West Chapter of the American Society for Metals; and the Twin City Foremen's Club. He was a graduate of Brown University.

Earl C. Souder, for 20 years industrial sales engineer for the Steel Mill Section of the East Pittsburgh, Pa., plant of the Westinghouse Electric Corp., died June 8 in Baltimore. Mr. Souder had been in the continuous employment of Westinghouse since immediately following World War I.

Robert R. Fauntleroy, retired president of the Moline Malleable Iron Co., St. Charles, Ill., died June 6. Mr. Fauntleroy spent practically his entire business career with Moline Malleable, serving as company secretary-treasurer from 1905 to 1921, and president from 1921 to 1948. Mr. Fauntleroy was president of the American Malleable Castings Association in 1929 and of its successor organization, the Malleable Founders' Society, in 1933 and 1934. During World War II, Mr. Fauntleroy served as chairman of the Malleable Industry Advisory Committee to the Office of Price Administration. In June, 1948, Mr. Fauntleroy was presented with the Malleable Founders' Society's Charles H. McCrea Medal for "outstanding contributions toward progress and development in the malleable iron industry."

E. H. Schleede, 49, development engineer on Plastic Patternmaking for the Industrial Division of the United States Gypsum Co., died June 8 following a heart attack. An authority on patternmaking, Mr. Schleede was a frequent speaker before chapter, regional and national meetings of the American Foundrymen's Society and the American Ceramics Society, and recently conducted training courses for patternmaking apprentices in several metropolitan areas.

A. F. S. Employment Service

To contact firms seeking personnel through "Help Wanted" items write to American Foundrymen's Society, 222 West Adams St., Chicago 6, designating Item Number and issue of AMERICAN FOUNDRYMAN in which published. A.F.S. Applicant Registration Form then will be sent to applicant for filling in and returning to A.F.S. Headquarters. The form will be sent by Headquarters to the firm and all negotiations thereafter must be made between applicant and firm.

Firms desiring to contact applicants should write A.F.S. Headquarters on firm letterhead, designating Item Number and issue.

POSITIONS WANTED

PW118—Foreman or Superintendent: 26 years practical experience (foreman 16 years) in light, medium and heavy work, production and jobbing, gray iron and steel. Extensive machine molding experience, loose pattern bench and floor molding. Well versed in rigging, gating and feeding, molding and core sands, cleaning room and cupola. Good record handling men. Age 43.

HELP WANTED

HW507—Metallurgical Sales: An attractive metallurgical sales development position is available in Detroit for a graduate metallurgical engineer who is 30 to 36 years old and who has had experience in the production of cast iron.

HW508—Pattern Shop Supervisor: Need man to head 15-man pattern shop. Good opportunity. Non-ferrous foundry. Write, giving experience.

CHAPTER ACTIVITIES NEWS

Eastern New York

John M. Jones
American Locomotive Co.
Publicity Chairman

THE MAY 17 MEETING of the Chapter was held at the Circle Inn, Lathams, N. Y., and featured an address by Oscar Carlson of the Carlson Pattern Works, Springfield, Mass., on matchplates. Mr. Carlson presented an interesting motion picture in conjunction with his talk. This was the first meeting held by the Chapter on the subject of matchplates. At this meeting the new slate of officers was elected and will be installed at the June meeting.

Wisconsin

Frank M. Jacobs
Standard Brass Works
Chapter Reporter

OLD TIMERS AND APPRENTICES Night, held May 13 at the Schroeder Hotel, Milwaukee, featured the awarding of prizes to winners of the Chapter's Apprentice Contest, and placques to men who have completed 50 years of service to the foundry industry. Preceding the awards banquet, parties were given for the old timers and apprentices.

At the banquet, 1949-50 Chapter officers and directors were introduced to the membership, awards were presented, followed by community singing and a floor show.

Wisconsin Chapter old timers who received placques in recognition of their 50 years with the foundry industry were:

Fred Ristow, Cherry-Burrell Corp., who started with the Manitowoc Seaping Seating Co. in 1894; Frank E. McIntyre, who first began work in a foundry at St. Aubuns, Vt., in 1884; Max Goldberg, Modern Equipment Co., Port Washington, Wis., who started with the Port Washington Malleable Iron Co. in 1891; Julius Roller, who began with the Whitehall, Wis., Sewing Machine Co. in 1878.

Fred Popke, Kohler & Co., Kohler, Wis., who began as a foundryman in Breslau, Germany, in 1895; John Fabiszak of the Allis-Chalmers Mfg. Co., Milwaukee, who first worked for the Prescott Mfg. Co. in 1898; Luke J. Seidel, Badger Malleable Iron & Mfg. Co., who started with the Stowell Mfg. & Foundry Co. in 1899.

Emil Katzner of the International Harvester Co., Milwaukee, who began his career as a foundryman with the Waukesha Malleable Iron Co. in 1899; August Wolff of the Bucyrus Erie Co., Milwaukee, who began foundry work with the Stowell Mfg. & Foundry Co. in 1896; Fred Haag of the Bucyrus Erie Co., Milwaukee, who began work with the Ohio Machine Co. in 1896; and Gustave A. Borck of the Maynard Electric Steel Castings Co., Milwaukee, who was apprenticed as a foundryman with the Allis-Chalmers Mfg. Co., Milwaukee, more than a half century ago.

First prize winners in the Gray Iron, Steel and Non-Ferrous Molding, and Patternmaking Divisions of the Wisconsin Chapter's Apprentice Contest were each awarded $15, second prize winners $10 and third prize winners $5. (Winners of the Chapter's Apprentice Contest were announced in the May issue of AMERICAN FOUNDRYMAN, Page 111.)

F. E. Bates, Worthington Pump & Machinery Corp., Buffalo, (left) welcomes Retiring Chapter Chairman Martin J. O'Brien, Jr., Symington Gould Corp., Depew, N. Y., to the ranks of past chairmen of the A.F.S. Western New York Chapter with the presentation of a past chairman's pin.

Eastern Canada

A. J. Moore
Montreal Bronze, Ltd.
Publicity Chairman

CLIMAXING the 1948-49 season, Retiring Chapter Chairman O. L. Voisard, Robert Mitchell Co., Ltd., St. Laurent, turned over the gavel symbolic of chairmanship to his successor, J. H. Newman, Newman Foundry Supply Co., Ltd., Montreal, at the Chapter's May meeting.

Other events on the evening's program were the presentation of prizes to winners of the Chapter's Apprentice Contest and Technical Papers Contest by W. T. Shute, Canadian Car & Foundry Co., Ltd., Longue Point, Chapter Educational Chairman, and reports by the chairmen of various committees.

British Columbia
Norman Terry
Canadian Sumner Iron Works, Ltd.
Chapter Secretary

THE LAST TECHNICAL SESSION of the 1948-49 season, held May 20, featured as speakers Edward J. McAffee, Master Patternmaker, and Edward Boyles, Master Molder, both of the Puget Sound Naval Shipyard, Bremerton, Wash.

Speaking on the *"Use and Advantages of Plastic Patterns,"* Mr. McAffee illustrated his talk with colored slides showing every step in the making of plastic patterns and with actual samples of the type of plastic patterns available to the foundry industry. This was a most interesting subject and was well presented.

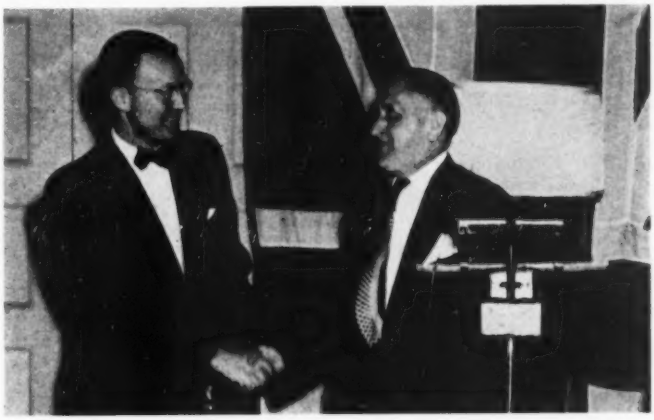
The next speaker, Mr. Boyles, who has conducted extensive research into the development of insulating materials for use in risers for non-ferrous, iron and steel castings, also had several samples of his work on display and illustrated his interesting talk with slides.

The Chapter's Annual Meeting will be held June 21, and will be devoted to social activities – the only exception being the election of officers and the awarding of Apprentice Contest prizes.

Texas
W. H. Lyne
Hughes Tool Co.
Publicity Chairman

THE APRIL 15 MEETING, held at the Hotel Angeline, Lufkin, featured an all-day plant visitation at the Lufkin Foundry & Machine Co., and at Texas Foundries, Inc., Lufkin. Dr. Ralph L. Lee, General

Oscar Carlson (right), Carlson Pattern Works, Springfield, Mass., speaking on matchplates at the May meeting of the Eastern New York Chapter.



J. H. Newman, Newman Foundry Supply, Ltd. (left), incoming chairman of the Eastern Canada Chapter, shakes hands with O. L. Voisard, Robert Mitchell Co., Ltd., retiring chairman, at the Chapter's May meeting.

A.F.S. National President W. B. Wallis (behind microphone) smiles at one of the witticisms of Dr. Ralph L. Lee, General Motors Corp. (standing), who spoke on leadership at the Texas Chapter's May meet.

Meeting recently in Muskegon, these officers and directors of the Western Michigan Chapter made plans for the Chapter's Ninth Annual Outing and Picnic, to be held August 20 at the Pontaluna Golf Club, Muskegon.

Occupants of the speakers' table at the May meeting of the Central Ohio Chapter were, left to right: Robert A. Willey, Commercial Steel Castings Co., Marion; Gray Lummis, A. P. Fire Brick Co., Columbus; E. M. Durstine, Keener Sand & Clay Co., Columbus; and J. S. Schram, United Oil Mfg. Co.

Wisconsin Chapter Apprentice Contest winners received cash prizes and a big grin from Contest Chairman Andrew Bottoni, Milwaukee Vocational School, at the Chapter's "Old Timers and Apprentices Night," held May 13.

Motors Corp., gave an interesting and amusing talk on *"Qualifications of a Leader."*

Dr. Lee's command of the language and ability as a speaker made his talk at once fascinating, forceful, comical, serious and hilarious. Certainly the qualifications outlined by Dr. Lee would have given any boss an inferiority complex. However, the speaker's truisms were obvious and forceful.

One striking example, which probably hit home to more foundrymen than any other, was Dr. Lee's description of a foreman's desk and office. After the talk, it is certain that supervisory personnel went back to their jobs and did some straightening up and cleaning out of long-forgotten corners.

The meeting was climaxed by a dinner at the Angelina Hotel. President Thomas Shartle of the Steel Founders Society of America, delivered a brief address, and Colonel Cal C. Chambers, president of Texas Foundries, Inc., presided.

Mo-Kan
Thomas F. Shadwick
Witte Engine Works
Chapter Reporter

"Core Sands and Binders" was the topic of O. J. Meyers, Werner G. Smith Co., Minneapolis, principal speaker at the May 18 meeting of the Chapter, held at Rockhurst College, Kansas City, Mo.

The meeting, attended by 33 members and guests began in the Campus Cafeteria, where a fellowship hour was held preceding dinner. William Maness, Witte Engine Works, Kansas City, Mo., a new member, was appointed Chapter photographer. John Westwood, a Kansas University student interested in foundry engineering was a first-time guest.

Speaking on *"Core Sands and Binders,"* Mr. Meyers described the various types of core sands and binders and told how to use them for best results. The speaker stated that it is necessary for the foundryman to know his sands and binders in order to produce cores of good quality with minimum cost and loss. Foundrymen should know grain sizes and shapes, clay content, properties of oils and binders and ways in which foundry sand absorbs moisture, he said.

Mr. Meyers explained the advan-

Oldest old timer at the Wisconsin Chapter's "Old Timers and Apprentices Night," May 13, was Julius C. Roller, retired, who began his career as a foundryman in 1878.

tages of using cereal binders for greater green strength and collapsibility, but said that gas and smoke result when too much is used. He pointed out that oil sands pack and make a dense core which results in a better finish, prevents moisture pickup and adds dry strength to the core. However, the speaker said, when too much oil is used in cores, gases are formed in excessive quantity, causing defects and burning employees' eyes.

The speaker illustrated his talk with slides showing practical sand testing equipment, tabled guide charts and forms used in testing and controlling core sands.

M.I.T.
Richard A. Poirier
Technical Secretary

AT THE LAST MEETING of the season, May 11, several students who worked in foundries gave a brief account of their work and their opinions of the industry. The speakers for the evening were: Roland Ruetz, John Fries, Kenneth McGrath, Randall Cleworth, and Professor Howard F. Taylor.

The evening opened with a supper followed by a short business meeting. Each student gave a short talk on his experiences in the foundry industry. Although each worked in different foundries, all four students stressed several common objectives. Above all, they said, a summer student must learn to get along with people. A student must be able to have the workers look upon him as a worker rather than a student. Generally a student is well received by the executives of the foundry in which he is to work. Randall Cleworth stressed the need for a student to do more studying under his own guidance in order to obtain the initiative he will need in his work.

Prof. Howard F. Taylor told of two young graduates who have been working in a large foundry for a few years. Both had a fundamental knowledge of casting and

(Continued on Page 86)

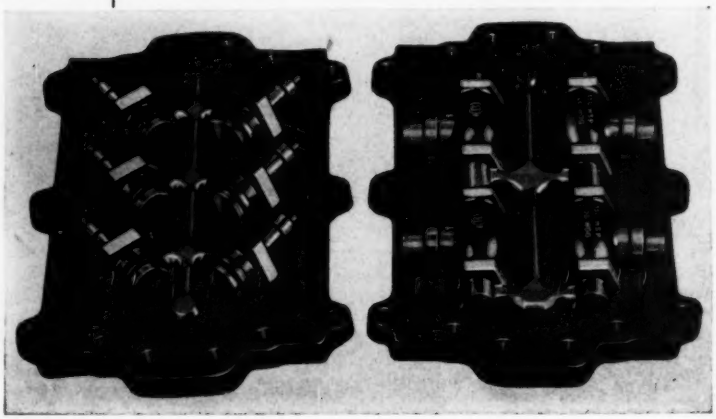
Newly-elected officers and directors of the Tennessee Chapter, photographed at the Chapter's May meeting are, standing, left to right: Director Porter Warner, Jr., Porter Warner Industries, Inc.; Sam C. Northington, Combustion Engineering Co.; Lester Bealer, American Brake Shoe Co.; and W. P. Delaney, Eureka Foundry Co. Seated, left to right: Secretary-Treasurer Herman Bohr, Robbins & Bohr; Vice-Chairman P. A. Arnold, U. S. Pipe & Foundry Co.; and Chairman Karl Landgrebe of the Wheland Co.

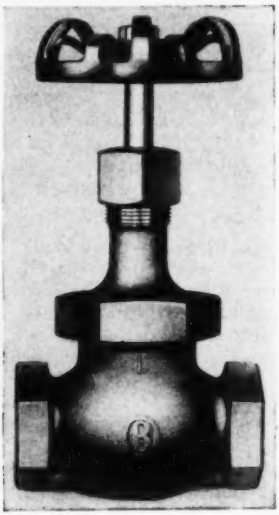
Robert Langsenkamp (center), retiring chairman of the Central Indiana Chapter, congratulates newly-elected Chapter officers at the May 23 meeting. Left to right: J. W. Giddens, International Harvester Co., incoming vice-chairman; S. F. Swain, Golden Foundry Co., incoming chairman; Mr. Langsenkamp; incoming Treasurer Ray Fickenworth, C & G Foundry & Pattern Works; incoming Secretary Paul Falk, Electric Steel Castings Co.

MASTER CONTROL

in your patterns is the first step toward control in your castings.

A globe valve is a means of control. In order to maintain this control, valve castings in themselves must be controlled. They must have the strength to withstand high pressures over a long period of time, and can have no weak spots or flaws.





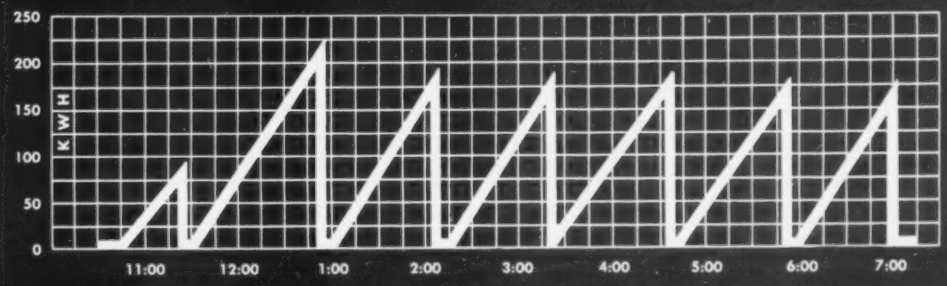
These copper patterns mounted on Berkshire molding plates, produce dependable brass castings for this valve. **THE OHIO BRASS COMPANY OF MANSFIELD, O.,** selected Master Pattern Company patterns to help them maintain the high standard of their valves. They know that controlled pattern accuracy pays.

MASTER PATTERN COMPANY

1317 MAIN AVENUE — CLEVELAND 13, OHIO

DESIGNERS AND MANUFACTURERS OF PERMANENT MOLDS, WOOD AND METAL PATTERNS AND MODELS

DETROIT ROCKING ELECTRIC FURNACE



One month's operation of type LFY, 175 KW, 700 lb. nominal cold charge capacity Detroit Rocking Electric Furnace. High strength, alloy automotive irons poured at 2800-3000° F.

• No. heats per day—7 • Av. heat weight—1000 lbs. • Total lbs. cold melted—168,930 • Av. power consumption, including preheat—549 KWH/ton • Av. power cost @ 1¼c/KWH—$6.86 • Av. electrode consumption—4.15 lbs./ton • Av. Electrode cost @ 22c/lb.—$.913/ton • Av. no. heats/lining—253 (9-month average) • Av. refractory cost—$3.64/ton.

NOTE: *Operator handles two such furnaces all day. Furnaces are equipped with automatic electrode control as well as automatic rocking control.*

FASTER, CHEAPER, BETTER MELTS IN SINGLE or MULTIPLE OPERATION

Detroit Rocking Electric Furnaces achieve increased production at reduced costs, with rigid control over quality.

The above operating graph of a type LFY, 175 KW, 700 lb. nominal cold charge capacity Detroit Rocking Electric Furnace melting high strength alloy automotive irons is typical of one day's economical operation. Multiply this day's savings by the working days of the year and you realize the owner's great savings.

Besides optimum power use, all-electric operation precludes handling and storing messy, bulky fuels. Equally advantageous is the positive control of operational speed, composition quality and other melting factors. Out-of-production time due to burned-out linings is minimal. Spare, previously-lined furnace shells are quickly, easily installed.

Other saving features are fast, uniform outputs; lowest metal loss by shrinkage; conversion of shop borings and turnings with least loss from oxidation. The arc is automatically established clear of the molten bath at all times. The metal is never a part of the electrical circuit, assuring uniform temperatures within the melting chamber.

Detroit Rocking Electric Furnaces are available in 10 to 4000 lb. capacities with either conical or cylindrical chambers. Individually designed to meet your plant electrical specifications.

Whether you melt ferrous or non-ferrous metals, send us your production data. Our engineers will furnish you facts on how you gain ultimate operating economy with positive melt-quality control, using the Detroit Rocking Electric Furnace suited to your requirements in size, capacity and use. Address:

DETROIT ELECTRIC FURNACE DIVISION

KUHLMAN ELECTRIC CO. • BAY CITY, MICHIGAN

FOUNDRY FIRM Facts

High Frequency Foundry Sales Corp., an organization that will act as sales representative for high frequency foundry core baking equipment manufactured by the **Thermex Division of The Girdler Corp.,** Louisville, has opened offices at 76 Beaver St., New York 5, N. Y. Heading the new organization are Nat Levin, John H. Garger and James P. Moran, formerly development engineer, assistant sales manager and research engineer, respectively, of the Induction Heating Corp., Brooklyn. In addition to offering a complete technical survey service to the foundry core room, High Frequency Foundry Sales Corp. will handle allied lines of foundry equipment.

Federated Metals Division, American Smelting & Refining Co., announces the managerial reorganization of its Aluminum Department and the removal of its executive offices from the Fisher Bldg., Detroit, to the company's home office at 120 Broadway, New York. R. A. Quadt, formerly assistant manager of the General Aluminum Department, has been appointed director of Aluminum Development under John A. West, manager of Technical Operations. Mr. Quadt will assume most of the directive functions formerly held by J. B. Neiman, who recently resigned as manager of the General Aluminum Department.

Vacuum Casting Corp., Philadelphia, was recently formed to develop and license a new process for casting and refining metals in a vacuum. Named president of the new corporation is Frederic O. Hess, president of Sellas Corp. of America. Rawson L. Woond, president of the Arwood Precision Casting Corp., Brooklyn, was elected treasurer; and E. Welford Mason, secretary. The inventor of the new process, which is applicable to the manufacture of aircraft turbines, ordnance parts, gas turbines, steel ingots and other metal products is Davidlee Von Ludwig of Brooklyn, who has been appointed director of research for the new corporation. According to its inventor, the principles of refining and casting metals in a vacuum will result in precision production of Alnico castings and will prevent contamination of metal and gases during casting. Company officials claim that the new process will aid in the commercial development of titanium and titanium alloys, chromium, beryllium, molybdenum, and in precision casting, of parts utilizing high temperature alloys and high conductivity electrical materials. **Arwood Precision Casting Corp.,** Brooklyn, has been granted the first license on the process. Licenses to other refining and casting corporations throughout the United States will be granted shortly.

Ace Core Co., Blue Island, Ill., specializing in core production, is back in operation after a disastrous fire early in May, according to Ervin Marcec, head of the organization. Previously located in Chicago, Ace Core was completely burned out when the roof caught fire from a blazing neighboring building. The company makes all types of cores for every type of foundry from bench work to large floor jobs.

Foundry Services, Inc., 280 Madison Ave., New York, announces the appointment of **Dayton and Bakewell,** 1939 Santa Fe Ave., Los Angeles 21, as its representative for FOSECO products in the Los Angeles area, and the appointment of the **Industrial Foundry Supply Co.,** 1431 Howard St., San Francisco 3 as San Francisco area representative for FOSECO products.

J. Wesley Cable, high frequency heating consultant to the foundry industry, announces the removal of his offices from 325 East 41st St., New York, to 76 Beaver St., New York 5.

Baker Industrial Truck Division of the Baker-Raulang Co., announces the removal of its general offices, including purchasing, sales, engineering and service departments to 1250 West 80th St., Cleveland 2. The Division's manufacturing operations, presently located at the West 25th St. plant, will be moved to the 80th St. location in the near future.

The purchase of land and buildings formerly occupied by the **Duquesne Smelting Corp.** in Pittsburgh is announced by the **W. E. Moore Co.,** Pittsburgh, and its associated companies—the Pittsburgh Lectromelt Furnace Corp., the Pittsburgh Lectrodryer Corp., and the West Penn Machine Shops. The newly-acquired property adjoins that of the Moore plants in Pittsburgh and comprises three and one-half acres of land and 10 buildings, with a total of 93,000 square feet of floor space.

Link-Belt Co., Chicago, announces that several of its branch offices have been moved to larger quarters. They are: Cleveland office, moved to 311 Hanna Bldg.; the Baltimore office, moved to 2315 St. Paul St.; the Huntington, W. Va., office, moved to 1009 Fifth Ave.; and the Newark, N. J., office, moved to 31 Clinton St.

Air Reduction Co., New York, announces the opening of a $250,000 oxygen plant in Flint, Mich., and an acetylene plant in Acton, Mass. The oxygen plant will produce more than four million cubic feet of oxygen per month, will operate on a three-shift, 24-hour day, and will have a staff of from 15 to 20 employees. The acetylene plant at Acton has a rated capacity of 100,000 cubic feet of acetylene per day.

Lake Shore Engineering Co., Iron Mountain, Mich., announces the formation of a Conveyor Division to manufacture and sell lightweight, power-driven portable belt conveyors for handling bulk and packaged materials. Horton Conrad, president of Material Movement Industries, Inc., Skokie, Ill., former manufacturer of the machines, has been appointed to direct sales of the new Division and announces that Material Movement Industries, Inc., will be dissolved but that its dealer organization will handle the new Division's line of conveyors.

A perfect attendance record at the 53rd A.F.S. Convention in St. Louis, May 2-5, was scored by the Werner G. Smith Co., Division of Archer-Daniels-Midland Co., Cleveland. This core oil supplier's entire complement of 24 sales and technical representatives attended the Convention.

Foundrymen who look at binders— without BLINDERS

...see these big reasons for using CYCOR* 151

IT PAYS to switch from the conventional binders to Cyanamid's improved synthetic resin binder, CYCOR 151, for sand cores. Just make this comparison yourself and see.

You'll find that...

CYCOR 151 bakes in faster time—at lower temperatures... produces more uniformly high-quality cores per oven.

You get unusually good collapsibility... with less cleaning required.

CYCOR 151 costs no more than standard binders, yet saves you money because you purchase only the neat synthetic resin, modifying it with fillers and extenders to meet your special requirements.

You'll find, in short, that CYCOR 151 is what you have been looking for. Write for further information. Plastics Department, American Cyanamid Company, 30-36 Rockefeller Plaza, New York 20, N. Y.

*Reg. U. S. Pat. Off.

AMERICAN Cyanamid COMPANY

PLASTICS DEPARTMENT

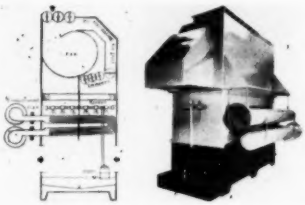
30-36 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

NEW Foundry Products

Readers interested in obtaining additional information on items described in New Foundry Products should send requests to Reader Service, American Foundryman, 222 W. Adams St., Chicago 6, Ill. Refer to the item by means of the convenient code numbers.

After Cooler

JL1—The Niagara Aero After Cooler dehydrates compressed air or gas by cooling it to a temperature below the dry bulb temperature of the atmospheric air, thereby removing the moisture that condenses at that point and preventing further condensation of water in air or gas lines in



use. This is done by evaporating a recirculating water spray on the surface of a coil through which the compressed air passes, creating a temperature close to the wet bulb temperature of the surrounding atmosphere, lower than the dry bulb temperature and also below the summer surface water temperature. Protection against freezing is offered by thermostatic controls.

Core Oils

JL2—Hy-Ten 304, a moderately-priced core oil, is claimed by its manufacturer, E. F. Houghton & Co., to maintain uniformity of performance under practically all foundry conditions, and to provide satisfactory strength throughout all sections of all types of cores. Field tested for more than a year, Hy-Ten 304 is designed to provide satisfactory cores over a wide time cycle of baking. Data sheet available upon request.

Smoke Density Control

JL3—Designed to indicate industrial smoke levels, General Electric Co.'s smoke density indicator and control can also be used to control over-the-fire heated air to the fire-box, reducing excessive smoke and improving fuel consumption and boiler efficiency. The equipment consists of a light source, phototube holder, and an enclosure containing control and indicator calibrated in Ringlemann units. Used in conjunction with this equipment, a chart type recorder provides a continuous record of smoke density and can be used to measure general operating efficiency and as proof of smoke ordinance compliance. Sturdily-constructed and dust tight, the equipment is easily installed.

Green Core Impact Tester

JL4—The No. 620 Green Core Impact Tester manufactured by the Harry W. Dietert Co. is designed to determine the height to which a core will stand, how well overhanging parts will hold, what the effect of jolting during transport will be,

and whether a cylindrical core will stand rolling-out onto a plate. The number of jolts required to crack a core are used as a measure of the ability of a core mixture to be rolled on a plate. Overhang possibilities are measured by jolting a test core formed with an overhang. A dial indicator measures the slump suffered by a core when subjected to a standard jolt.

Immersion Thermometer

JL5—Providing maximum temperature readings at 400 to 1500 F, Electric, P. & V.R. Co.'s new dial type immersion thermometer is easy to read and does not require delicate handling. A stainless steel cylinder, 5 to 9 in. long encloses temperature-sensitive element, mounted at the head of a 30 in. steel tube leading to dial head with pointer that travels through 240 degrees over a 4-in. scale. Thermometer is gas filled and independent of changes in ambient temperatures. Wood handle completes assembly and all instruments hang by convenient eye hook on handle. Instrument is designed to withstand hard use without damage to sensitive end or measuring element. High scale numerals make dial easily readable.

X-Ray Diffraction Unit

JL6—A high intensity, water cooled x-ray diffraction unit and a high, intensity, high-angle spectrometer, of particular value in classifying and identifying metals and alloys for grain size, orientation, and other physical and chemical changes, is announced by the North American Phillips Co. The diffraction unit incorporates a new high capacity, full-wave rectified high voltage generator, new automatic control system, a modern control panel with kilovolt and milliampere meters, an improved cooling system and automatic beam shutters. As many as four different cameras may be operated simultaneously with the unit. The 180 degree, high-intensity, high-angle Geiger counter x-ray spectrometer may be attached to the water-cooled diffraction unit, in units of one or two. As many as three different diffraction cameras may be used with one spectrometer unit simultaneously.

Portable Magnetic Separators

JL7—A portable, lightweight, inclined belt type magnetic separator to meet foundry requirements for recovery of scrap and sand cleaning has been developed by the Dings Magnetic Separator Co. Head

drive pulley for the inclined belt automatically effects a sharp separation of magnetic and non-magnetic material at the discharge end of the conveyor. Separator

is completely portable and is provided with a motor drive for belt convevor. Magnetic pulley is weatherproof and magnetic permanence is guaranteed for life of the separator. Standard separators are available in lengths of seven or ten feet with belt widths of 12, 14, 16, 18, 20 or 24 inches. Capacities range from 40 to 80 tons of sand per day. The largest size machine can readily be moved about by one man.

Fine Grinders

JL8—Buehler Ltd. announces the addition of two types of fine grinders to its line of metallurgical apparatus. The AB Standard Fine Grinders and AB Low Speed Fine Grinders are designed for the wet preparation of metallographic specimens prior to final polishing operations in the metallurgical laboratory. Equipped with direct drive, these horizontal fine grinders are suitable for dry as well as wet fine grinding. All grits of abrasive cloths or papers may be used. Units may be supplied with interchangeable wheels.

Galvanizing Furnace Setting

JL9—A setting for galvanizing furnaces, claimed by its manufacturer, Furnace Engineers, Inc., to increase production as much as 50 per cent, increase pot life and reduce fuel consumption, allows for a minimum of fuel use during idling periods and provides for quick starting up. Test installation for galvanizing pipe, where normal pot life expectation was 20,000, produced 70,000 tons before pot required replacement, with no repairs necessary during production.

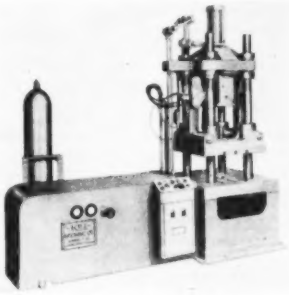
Dust Collector

JL10—The Type N Roto-Clone, developed by the American Air Filter Co., Inc., has been redesigned to permit wider application and improved performance. Developed in 1942, the Type N embodies a

hydrostatic precipitator that cleans the air by the combined action of centrifugal force and a thorough intermixing of water and dust-laden air, re-using the water without recirculation pumps or spray nozzles. The new Design 2 Type N Roto-Clone, with capacities through 48,000 cfm, maintains a lower pressure drop with the same cleaning efficiency and water recirculation rate and can be operated from 50 per cent to 120 per cent of its nominal rating without effecting its collecting efficiency. All sizes are available in either manual cleanout, sludge ejector or hopper bottom arrangement. Bulletin 277-A is available.

Die Casting Machine

JL11—The Kux Model HP-22, developed by the Kux Machine Co., is a cold chamber die casting machine designed for the production of parts with inserts cast in. This vertical type machine has its die plates mounted in a horizontal position, while its die plates operate in a vertical direction. Thus castings with inserts can be placed in the lower die half without difficulty, and the inserts will remain in



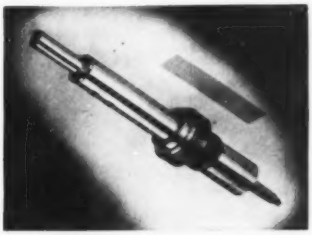
place throughout the die casting cycle. Model HP-22 has a self-contained hydraulic operating mechanism with an injection pressure multiplier for increasing injection pressure. Model HP-22 will produce castings weighing up to 4½ lb in aluminum and has a die space of 17¾ in. in between the bars.

Lift Truck Attachment

JL12—A revolving apron attachment which makes possible the turning over or dumping of lift truck loads by an hydraulic mechanism is now available for the Hyster Co.'s Models 20 and 40 lift trucks. Hydraulically controlled, a revolving head on which conventional fork arms are mounted turns 180 degrees in either direction from the center. Capacity loads of 1,725 lb with the Model 20, and 3,650 lb with the Model 40, may be turned. Load-Grab unit may be mounted on turntable of Model 20 in place of regular fork arms. Load-Grab side-squeezes loads with sufficient pressure to lift load without need of pallet. Load capacity of revolving apron in conjunction with Load-Grab unit is 1100 lb.

Recessing Tool

JL13—A large-size, automatic recessing tool, designed especially for use on radial drills, boring mills, large boring machines and drill presses, has been developed by the Maxwell Co. The new tool, employing standard rack and gear operating mechanism, can be used in conjunction with heavy machines to recess internal forms normally considered inaccessible for standard equipment, and can be used with



standard fixtures. Cutter feeds can be furnished in a ratio of approximately 1:3, as compared to spindle speed. Individual cutters can be made of either high-speed steel or carbide tipped. Cutter bits can be positioned to meet individual specifications, and can be located for cutting deep recesses in relation to the workpiece outer surface.

Synthetic Resin Binder

JL14—A new synthetic resin, Cycor 151, developed by the American Cyanamid Co. for the binding of sand cores, is a thermosetting resin made under controlled conditions and especially prepared as a water-resistant foundry core binder. Containing no filler or additives, Cycor 151 produces cores which are water-resistant, stand high humidity and long lay-overs in molds, and can be cured in either conventional or dielectric ovens. Only small quantities are required and short baking cycle increases oven turnover. Cycor 151 is claimed to require 33 to 50 per cent less baking time than standard binders at temperatures of only 350 F, and has excellent collapsibility. Amount of Cycor 151 and/or additives may be varied to obtain cores with green and baked tensiles, permeability, hardness and collapsibility as needed for various types of castings.

Fork Truck Ladle

JL15—A rotor-ladle attachment for foundry fork trucks is announced by Yale & Towne Mfg. Co. Designed for rapid transportation of hot metal from cupola to pouring floor and to pour molten metal without removing ladle from truck, the rotor-ladle attachment has a two-speed 360-degree rotor—the slower speed giving added control during actual pouring. Truck used in this application is an end control fork model of 54-in. wheelbase, 83-in. mast height, and 45 in. overall width. Truck has grade clearance of 3½ in., and a turning radius, outside edge of truck with 22-in. long forks, of 96 in. Turning radius of inside edge is 39 in. Truck has speed of 4 mph under full load, 5½ mph empty, and 2 mph loaded up to 10 per cent grade. Mast tilts 20 per cent to center the load. Ladle has capacity of 4150 lb. is 34½ in. in diameter by 39 in. in height.

FOUNDRY Literature

Readers interested in obtaining additional information on items described in Foundry Literature should send requests to Reader Service, American Foundryman, 222 W. Adams St., Chicago 6, Ill. Refer to the items by means of the convenient code numbers.

Electronic Core Baking

JL101—Data sheets on the electronic core baking process will be made available to foundrymen monthly by the Induction Heating Corp. and will contain both technical and production information on the process. Data Sheets 1 and 2, dealing with the fundamentals of electronic core baking, and the use of resin binders in electronic core backing, respectively, are now available. Requests for inclusion on the mailing list for these data sheets should be sent care of Reader Service, AMERICAN FOUNDRYMAN.

Centrifugal Steel Casting

JL102—A folder, *Casting Stainless Steel Centrifugally in Permanent Metal Molds*, published recently by the Cooper Alloy Foundry Co., describes a process developed primarily as a means of meeting the rigid requirements of large rings used in the Nene jet engine. The folder describes the development and techniques employed, the problems encountered and the solutions evolved in two years of pouring stainless and heat resisting castings in permanent molds at Cooper. Copies are available upon request.

"Yardsticks"

JL103—"*Yardsticks*," a unique pamphlet issued by the American Brake Shoe Co., contains the notebook jottings of Brake Shoe's president, William B. Given, Jr., on the subject of human weaknesses in employee relations. Witty and discerning, Mr. Given's "yardsticks" are brief and to the point and are an invaluable asset to any executive's desk.

Electric Furnaces

JL104—Pittsburgh Lectromelt Furnace Corp.'s recently-issued Catalog No. 7 of Moore Rapid Lectromelt Furnaces for melting and refining contains 64 illustrated pages of detailed electric furnace specifications, installation and operating data and applications. Beginning with a Foreword containing a history of the company, the booklet tells the story behind Lectromelt Furnaces, first manufactured in 1917, and goes on to describe their melting rate and holding capacity, and applications to making of billet size ingots and in gray iron production. Specification data include detailed descriptions of all working parts, shell diameters, capacity of substations, nominal sizes of heats and space requirements. The advantages of top charging electric furnaces are fully explained. Typical operating data are given on all Lectromelt furnace models. Concluding the brochure are tables showing standard space requirements on basis of floor type installation, export refractory data for estimating purposes, and data on motor generators and wall bushings. The brochure is illustrated profusely throughout with photographs.

Grinding Wheel Speeds

JL105—*Safe Speeds for Grinding Wheels* is the title of a 17-page booklet recently issued by the Grinding Wheel Institute. The booklet contains a non-technical discussion of the established rules governing safe operating speeds, prepared especially for the use of grinding machine operators, supervisors and safety engineers. The booklet explains the importance of not exceeding the maximum operating speed recommended by the wheel manufacturer and points out that in many cases productivity actually increases when the wheel is operated at a speed well under the maximum. Copies are available upon request free of charge.

Cupola Collectors

JL106—Bulletin 449 issued by the Claude B. Schneible Co. contains detailed information on the installation of Schneible Water Curtain Type "SW" Cupola Collectors. A complete explanation of the operation and advantages of this type of equipment is given, together with pictures of present installations and clearly-labeled diagrams showing typical arrangements of units and their functions. In addition, a comprehensive table of Cupola Collector dimensions and capacities is included.

Laboratory Equipment

JL107—Two new publications, a catalog and a manual, are now available from the Precision Scientific Co. Catalog 860NR illustrates and describes a complete line of laboratory apparatus and accessories for the preparation of metallographic specimens. Included are automatic polishers, specimen cutters, semi-automatic and hand-operated mounting presses and polishers and accessories. The manual, entitled "*Why?*," presents a comprehensive discussion on Freas Ovens, and describes their features and advantages in detail. Full information on incubators, ovens and sterilizers is included. Copies of either publication are gratis.

Graphite Molds

JL108—The May, 1949, issue of *International Digest*, published quarterly by the International Graphite Corp. features an article by John Putchinski of the Allis-Chalmers Mfg. Co., "*Graphite Molds Provide Low-Cost Centrifugal Castings at Allis-Chalmers.*" In the article, Author Putchinski describes how graphite rod has proved its worth at Allis-Chalmers, where over 1600 different items of major industrial equipment are produced by centrifugal casting. Copies of the issue are available upon request.

Sheffield Steel

JL109—Volume 1, Number 3 of Murex, Ltd.'s *Review*, published in England, contains an article by J. Lomas on the history of Sheffield steel. Of outstanding historical interest to all persons connected with the metals industries, this authoritative article outlines the history of this world-famous steel center and its products, dating back to the Fourteenth Century. Illustrated with old woodcuts and photographs, the article chronicles the early years of steel production and the work of Huntsman, Bessemer, Mushet, Sorby, Siemens and Brearley in establishing Sheffield steel as a world standard of excellence. Concluding the issue is a technical paper on Murex Laboratories' method for determination of tungsten in ferrotungsten.

Machining Malleable Iron

JL110—An article appearing in Bulletin No. 33 of *Malleable Iron Facts*, published by the Malleable Founders' Society and reprinted from *Iron Age* is available free of charge. "*Machining Malleable Iron*," is by members of the Society's Technical Council Subcommittee—Milton Tilley, National Malleable & Steel Castings Co.; W. M. Albrecht, Chain Belt Co.; L. R. Spann, Eastern Malleable Iron Co.; and James H. Lansing, Technical and Research Director of the Society. The article gives practical information on machining rates and techniques by taking a number of typical castings and describing the feeds, speeds, tool material, coolant and output.

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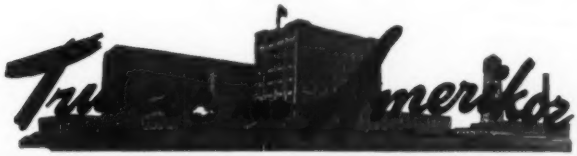

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CHAPTER ACTIVITIES

(Continued from Page 77)

design. They were given "free rein" on different design problems and soon established a reputation for themselves. Both were promoted but still prefer to wear old clothes and stay in the foundry itself.

Roland Ruetz announced Student Chapter plans for the next school year. Definite plans have been formulated for a very active year in foundry research and study. Several students have been placed in summer jobs and will concentrate on some phase of foundry engineering. In this manner, students at M.I.T. will conduct a foundry project in which research and study can be accomplished and in which less advanced students can be taught the fundamentals of casting.

The question period dealt with the ability of the foundry industry to absorb young engineers. It was agreed that the industry is very receptive to the value of technically trained young men.

Tri-State

F. E. Fogg
Acme Foundry & Machine Co.
Chapter Reporter

THE LAST BUSINESS MEETING of the year for the Tri-State Chapter was held May 20 in Coffeyville, Kan., and was designated "Acme Foundry Night" in recognition of that company's year-round attendance of Chapter meetings.

H. E. Elliott of the Dow Chemical Co., Midland, Mich., presented an interesting and enlightening discussion of magnesium foundry practice. The speaker supplemented his remarks with slides showing actual foundry work. A question and answer period followed the talk.

Chesapeake

C. A. Robeck
Gibson & Kirk Co.
Chapter Secretary-Treasurer

OFFICERS AND DIRECTORS of the Chesapeake Chapter, elected at the Chapter's May 27 meeting are as follows:

Chairman—J. B. Mentzer, Wood Embley Brass Co., Waynesboro, Pa.; *vice-chairman*—A. A. Hochrein, American Smelting & Refining Co., Baltimore; *secretary-treasurer*—C. A. Robeck, Gibson & Kirk Co., Bal-

(Continued on Page 88)

HEAVY DUTY CRANKSHAFTS
cast in High Test
NICKEL ALLOY IRON

Crankshafts ranging from 800 to 4000 pounds in weight, and from 6 to 18 feet in length . . . for large Diesel engines in marine, locomotive, and stationary power plants . . . are now produced commercially by Pacific Car & Foundry Company's efficient new casting method.

The photograph shows an unmachined 8-throw unit that weighs 2105 pounds. It was cast in high strength nickel-molybdenum gray iron at Pacific's foundry in Renton, Washington.

This nickel alloy iron, produced as an inoculated iron in the basic electric furnace, consistently meets strength specifications of 60,000 to 75,000 p.s.i.

Each shaft is stress-relief annealed, and x-rayed to detect possible internal defects.

These nickel-molybdenum cast iron crankshafts provide:

- **Low Notch Sensitivity**
- **Excellent Vibration Damping**
- **High Resistance to Fatigue**

Avoidance of expensive dies and forging equipment, the use of cores to eliminate unnecessary metal, and the fact that castings require less machine tool time . . . point to the economy of using nickel alloy irons.

Heavy duty crankshafts indicate the wide scope of applications for high strength nickel alloy cast irons. Our casting specialists will be glad to consult with you and suggest where nickel cast irons may be useful to you. Write us today.

This high test nickel iron crankshaft is cast in a mold set horizontally, and tilted slightly while pouring. Mounted in specially designed trunions, the mold is rotated 90° to the vertical position for cooling. This provides better feeding, improved directional solidification, and thus, sound castings.

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Over the years, International Nickel has accumulated a fund of useful information on the properties, treatment, fabrication and performance of engineering alloy steels, stainless steels, cast irons, brasses, bronzes, nickel silver, cupro-nickel and other alloys containing nickel. This information is yours for the asking. Write for "List A" of available publications.

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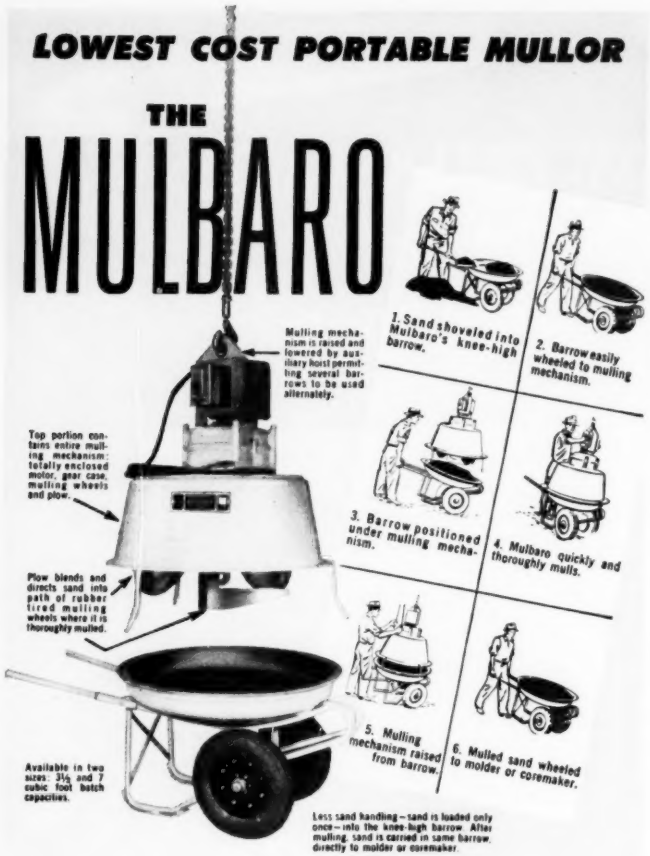
Mulling mechanism is raised and lowered by auxiliary hoist permitting several barrows to be used alternately.
Top portion contains entire mulling mechanism; totally enclosed motor, gear case, mulling wheels and plow.
Plow blends and directs sand into path of rubber tired mulling wheels where it is thoroughly mulled.
Available in two sizes: 3½ and 7 cubic foot batch capacities.
1. Sand shoveled into Mulbaro's knee-high barrow.
2. Barrow easily wheeled to mulling mechanism.
3. Barrow positioned under mulling mechanism.
4. Mulbaro quickly and thoroughly mulls.
5. Mulling mechanism raised from barrow.
6. Mulled sand wheeled to molder or coremaker.
Less sand handling – sand is loaded only once – into the knee-high barrow. After mulling, sand is carried in same barrow directly to molder or coremaker.

The *really* portable Mulbaro is easily moved about the foundry or core room and the sand is mulled in the same barrow in which it is brought to and taken from the mullor. The sand is handled only once! With an additional barrow or barrows, the Mulbaro mulls almost continuously. While the sand is being mulled in one barrow another is being loaded or unloaded. Thus the Mulbaro offers the capacity of two or more mullors for slightly more than the price of one . . .

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CHAPTER ACTIVITIES

(Continued from Page 86)

timore; and *technical secretary* – William H. Baer, Naval Research Laboratories, Washington, D. C.

Directors (terms expire 1950) – Lewis H. Gross, American Radiator & Standard Sanitary Corp., Baltimore; Earl Gaffney, Arlington Bronze & Aluminum Corp., Baltimore; Orville Scheel, American Hammered Piston Ring Division, Koppers Co., Baltimore.

Directors (terms expire 1951) – William H. Holz, American Brake Shoe Co., Baltimore; L. H. Denton, Baltimore Convention Bureau; Frank B. Gately, Flynn & Emrich Co., Baltimore.

Directors (terms expire 1952) – Blake M. Loring, Naval Research Laboratories, Washington, D. C.; T. B. Belfield, Cochrane Foundry Inc., York, Pa.; C. D. Galleway, Chambersburg Engineering Co., Chambersburg, Pa.

Tennessee

Carl A. Fischer, Jr.
Fischer Supply Co.
Chapter Reporter

THE CHAPTER held its regular monthly dinner meeting at Hotel Patten, May 27.

Prizes were awarded to winners in a quiz contest on "*Casting Defects.*" First prize, consisting of a rod and reel, went to C. C. Wilson of Enterprise Wheel and Car Co. of Bristol, Va.-Tenn.

Second prize was a tie between Thomas Alford of the Wheland Co. and Paul Arnold of U. S. Pipe and Foundry Co. They matched and Tom Alford won a picnic kit. Paul Arnold received tickets to the barbecue, to be held August 27 at the Signal Mountain Golf and Country Club.

Third prize, won by Samuel Northington of Combustion Engineering Co., consisted of tickets to the barbecue. The following also received tickets to the barbecue as 4th prizes: J. D. Cliett, Crane Co.; Albert Waller, Ross Meehan Foundry Co.; H. U. Huff, the Wheland Co.

New officers and directors were elected for the coming year by acclamation as follows: Karl Landgrebe, the Wheland Co., *chairman;* P. A. Arnold, U. S. Pipe &

(Continued on Page 90)

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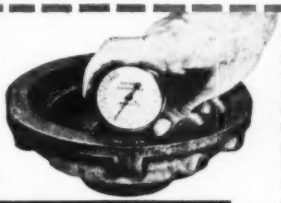

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Diamond 1200
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CHAPTER ACTIVITIES

(Continued from Page 88)

Foundry Co., *vice chairman;* Herman Bohr, Robbins and Bohr, *secretary and treasurer.*

Directors (terms expiring 1950) are—W. P. Delaney, Eureka Foundry Co.; Porter Warner, Jr., Porter Warner Co.; G. Frank Anderson, Chattanooga Implement and Mfg. Co.; William Willson of Athens Plow Co.

Directors (terms expiring 1951)—Charles Saunders, Tennessee Products Co.; D. B. Shannon, Somerville Iron Works.

Directors (terms expiring 1952)—Sam Northington, Combustion Engineering Co. and Lester Bealer, American Brake Shoe Co.

Northwestern Pennsylvania

James J. Farina
American Sterilizer Co.
Chapter Reporter

THE MAIN SPEAKER at the May 23 meeting, held at the Moose Club, Erie, was A. Lesley Gardner of the Pangborn Corp., Hagerstown, Md., whose subject was the mechanized cleaning of castings.

Following a description of the proper cleaning equipment for each type of casting job and ways of maintaining it, Mr. Gardner outlined the history of cleaning methods from the eighteenth century to the present. The theory, he said, is the same as it was then, but methods are more economical and efficient today.

Following Mr. Gardner's talk, a motion picture film was presented showing cleaning methods in the Ford Motor Co. foundry at Dearborn, Mich.

Lt. Col. Joseph Gauss of Erie was the speaker at the coffee talk session. His subject was "*With the Armored Forces in Germany*" and was highly interesting.

Birmingham District

J. P. McClendon
Stockham Valves & Fittings
Publicity Chairman

"FOUNDRY SAND PRACTICE" was discussed by Clyde A. Sanders, American Colloid Co., Chicago, at the May 20 meeting, held at the Tutwiler Hotel, Birmingham.

The 75 members and their guests who attended the meeting found Mr. Sanders to be a most interesting speaker and one who knows his

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A casting is only as good as the mold . . . that's why the A.F.S. FOUNDRY SAND TESTING HANDBOOK is a "must" for the foundryman's library. Order your copy today: $2.25 to A.F.S. Members; $4.00 List Price.

AMERICAN FOUNDRYMEN'S SOCIETY

222 W. Adams St., Chicago 6

subject thoroughly. Mr. Sanders brought out facts essential to securing best results from foundry sands. Chapter Vice-Chairman C. P. Caldwell, Caldwell Foundry & Machine Co., Birmingham, presided.

In a short business session, J. A. Bowers, American Cast Iron Pipe Co., announced the following nominations for Chapter officers and directors for 1949-50:

Chairman—C. P. Caldwell, Caldwell Foundry & Machine Co.; *vice-chairman*—Morris Hawkins, Stockham Valves & Fittings, Inc.; and *secretary-treasurer*—Fred K. Brown, Adams, Rowe & Norman, Inc.

Nominations for the Board of Directors included: W. Guy Bagley, Woodard Iron Co.; R. R. Deas, Hamilton Research Co.; H. W. Gethin, Alabama Clay Products Co.; and Dr. James T. MacKenzie, American Cast Iron Pipe Co.

The entire slate of officers and directors was elected unanimously.

Central New York

John A. Feola
Crouse-Hinds Co.
Publicity Chairman

THE ANNUAL OUTING and Business Meeting, concluding the Chapter's activities for the 1948-49 season, was held at Mountain Top Grove, Binghamton, June 10.

Hosts to the 115 members and guests were G. C. Ford of the Fairbanks Co., Binghamton; E. Kime and A. Hall of the Hallstead Iron Foundry Co., Hallstead, Pa.; Mrs. Louise Sacrey, Frank L. Phillips Co., Binghamton; and M. H. Steele, Sweets Foundry Co., Johnson City.

The day's program consisted of a buffet luncheon, refreshments and sports in the afternoon, and a business meeting at five o'clock, followed by a clam bake dinner.

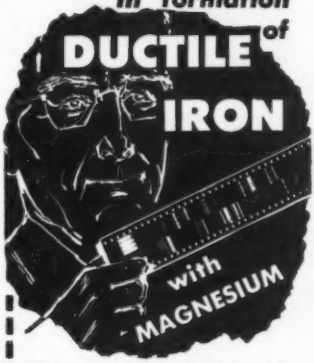
The following officers were elected for the 1949-50 season:

Chairman—J. F. Livingston, Crouse-Hinds Co., Syracuse; *vice-chairman*—David Dudgeon, Utica Radiator Corp., Utica; *secretary*—W. Dunn, Oberdorfer Foundries, Syracuse; and *treasurer*—D. J. Merwin, Oriskany Malleable Iron Co.

Directors to serve three years—H. Boardman, General Electric Co., Elmira; C. M. Fletcher, Fairbanks Co., Binghamton; and J. O. Ochsner, Crouse-Hinds Co., Syracuse.

Appointed as chairmen of vari-

RESULTS with SPECTROGRAPHIC LABORATORY CONTROL *in formation of* DUCTILE IRON



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ous committees were Peter E. Kyle, Cornell University, *Educational;* W. A. Mader, Oberdorfer Foundries, Syracuse, *Non-Ferrous;* and John A. Feola, Crouse-Hinds Co., Syracuse, *Publicity.*

Western Michigan

Stanley H. Davis
Campbell, Wyant & Cannon Foundry Co.
Chapter Vice-Chairman

NEW OFFICERS AND DIRECTORS of the Western Michigan Chapter, elected at the May 9 meeting of the Chapter at the Cottage Inn, Muskegon, (reported in the June issue of AMERICAN FOUNDRYMAN) are:

Chairman—C. H. Jacobson, Dake Engine Co., Grand Haven; *vice-chairman*—S. H. Davis, Campbell, Wyant & Cannon Foundry Co., Muskegon; *secretary*—R. P. Shaffer, Lakey Foundry & Machine Co., Muskegon; and *treasurer*—L. D. Ramsey, Paul Weiner Foundry Co., Muskegon.

Elected directors for three-year terms were—E. P. Babcock, Challenge Machinery Co., Grand Haven; K. C. McReady, Muskegon Piston Ring Co., Muskegon; and W. T. Holt, Enterprise Brass Co.

Elected a director for one year was Retiring Chapter Chairman W. A. Hallberg, Lakey Foundry & Machine Co., Muskegon.

It was announced that the Chapter's meetings for the 1949-50 season will be held the first Monday of each month instead of the second as during the last year. The meeting place of the Chapter will continue to be the Cottage Inn.

Central Michigan

A. J. Stone
Albion Malleable Iron Co.
Publicity Chairman

THE MAY 17 MEETING, held at the American Legion Clubhouse, Battle Creek, featured a talk by Frank G. Steinebach, Penton Publishing Co., on *"The Future of the Foundry Industry."*

Men, the speaker said, make up the industry—not the machines, materials and tonnages of castings produced. During the war, Mr. Steinebach added, the foundry industry was publicized because the War Manpower Commission made an effort to conserve the industry's manpower in order to overcome the castings shortage.

Since the war, the speaker said, several factors have influenced the production of castings. The first of

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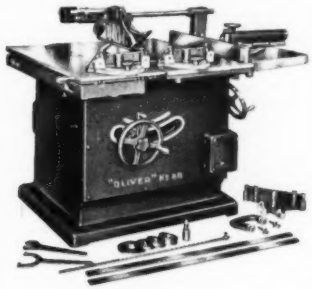

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Saves time for pattern makers . . .
Write for Bulletin No. 88-D
OLIVER MACHINERY COMPANY
Grand Rapids 2, Mich.

these is the threat of future war, the second material shortages and the third the increased cost of labor.

In the future, Mr. Steinebach said, further modernization and mechanization of the foundry industry will present new problems to be overcome in order to continue advancement of the industry.

The foundry industry, Mr. Steinebach said, is a good index of the rise and decline of business. Early this year, the consumer market was temporarily at a standstill because prices were too high for the majority of the people and the ratio of yearly income to the cost of luxury items was too low.

The speaker said that open house visitations to foundries not only promote better understanding of the industry on the part of the community, but encourage the foundries themselves to promote better housekeeping. Visitations, he added, are undoubtedly one of the cheapest forms of advertising.

Dr. Austen J. Smith of Michigan State College was technical chairman for the meeting and Prof. C. C. Sigerfoos, also of Michigan State College, presided.

Central Indiana

W. K. Mitchell
L. W. & W. K. Mitchell Co.
Chapter Reporter

PLANS FOR THE ANNUAL PICNIC and outing, tentatively set for September 10, were discussed by the Central Indiana Chapter Board of Directors at a meeting held June 13 in the Athenaeum, Indianapolis. S. F. Swain, Golden Foundry Co., Columbus, Ind., newly elected chairman, formally accepted the post from Retiring Chairman Robert Langsenkamp, Langsenkamp-Wheeler Brass Works, Indianapolis, and presided over the meeting.

Jack W. Giddens, International Harvester Co., Indianapolis, new vice-chairman, reported progress made on securing speakers for the coming season. Allan J. Reid, General Refractories Co., Indianapolis, was renamed membership chairman and W. K. Mitchell again was appointed chapter reporter for the 1949-50 season. Robert Spurgin, Swayne-Robinson & Co., Richmond, Ind., will assist Mitchell.

After outlining plans for a sustained membership drive, to be held next fall, Chairman Swain set August for the next Directors' meeting.

PROPER DESIGN–
still the most
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Despite the great advances in the use of alloy steels, the shape and proportions of a part are still of more vital significance than its material.

In an overall view, we should rate Design (1), the choice of the proper Steel (2), and its Treatment (3), in that order of importance. All are, of course, matters of great concern, but if the design is wrong then the proper choice of steel and its successful treatment serve no useful purpose.

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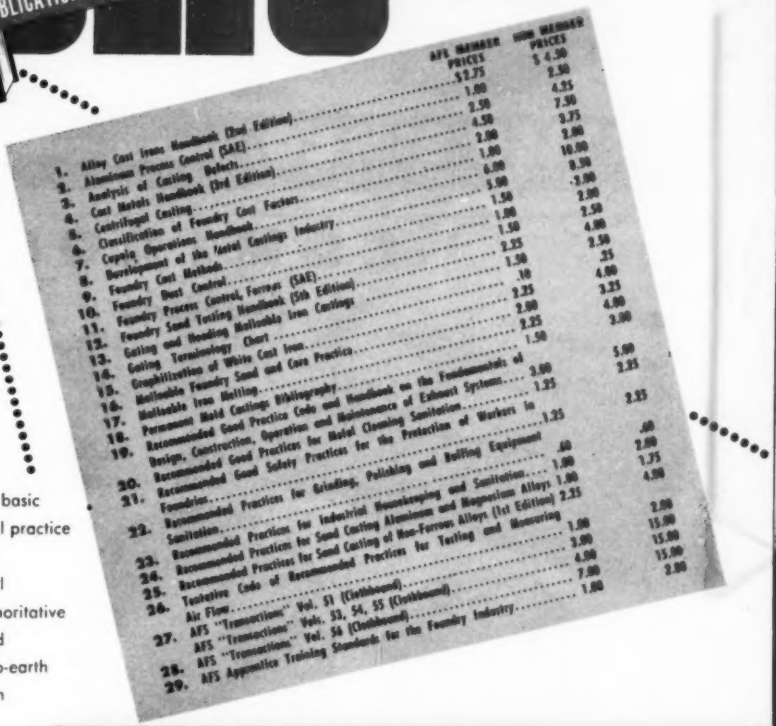

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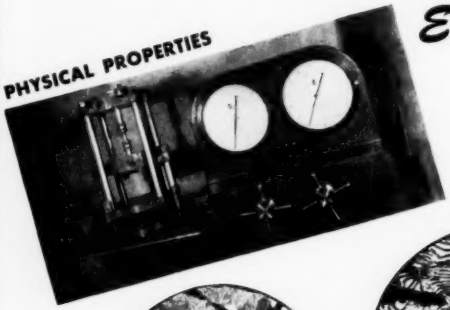

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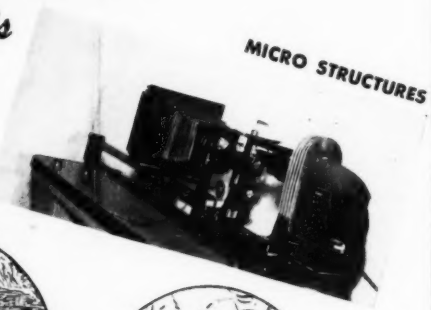
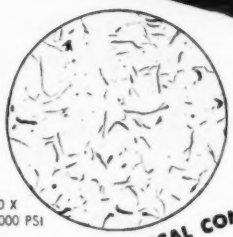


CAST IRON

FOUNDRY PROCEDURES



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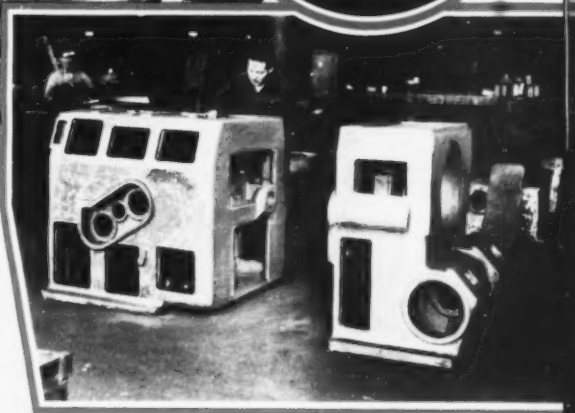

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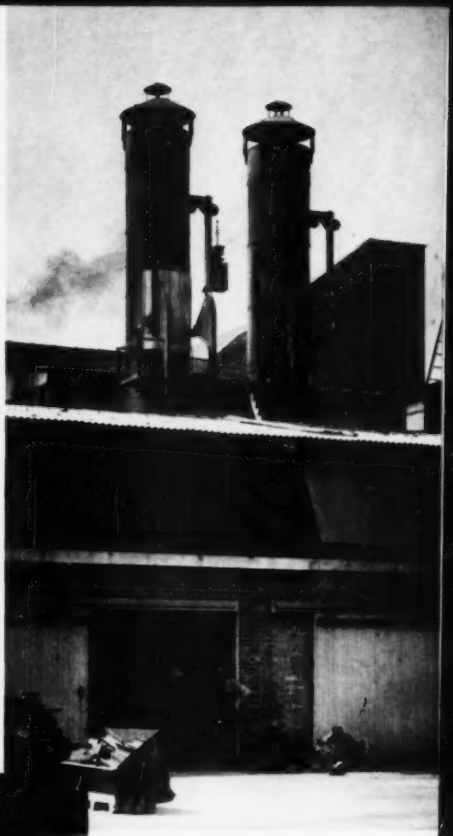
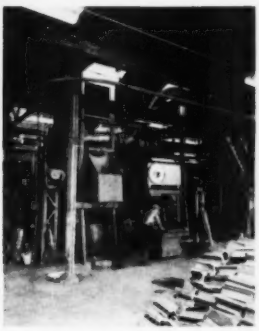


Bottom-dump scale-lorry suspended from monorail . . . shown in material yard

These two Whiting #4 Cupolas are served by side-dump skip hoist chargers



Here the monorail lorry discharges into the skip hoist charging bucket

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